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Environmental selection, the missing term in Darwinism

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Abstract. A serious terminological and conceptual problem of evolutionary theory is pointed out. At the present, the sexual selection could be considered a special type of natural selection as well as an independent process operating in parallel with natural selection. Some people use the term „natural“ in the sense „nonartificial“, „native“ while others in the sense „caused by nature, by the biotic or abiotic factors of environment“. The origin of this discrepancy is clear. When Charles Darwin introduced the term „sexual selection“ as the name for the process accompanying the competition among members of the same sex for mating opportunities, he failed to introduce a complementary term for all other forms of nonartificial selection. According to my opinion the term natural selection should stay reserved for its original purpose, as the general term covering all forms of nonartificial selection. There are no problems with its special form, sexual selection. For all other types of natural selection a new term – environmental selection should be introduced.

Evolution, sexual selection, natural selection, environmental selection

Whenever the problems of sexual selection are discussed, the author faces a serious terminological problem. Sexual selection could be considered either a special type of natural selection or an independent process operating in parallel with natural selection. Both concepts have their proponents and opponents, and both can be supported by historical and logical arguments.

It can be claimed that there is nothing „unnatural“ about sexual selection. Darwin introduced the term natural selection as a name for a process operating analogously to a process of artificial selection, but without human intervention. According to this criterion, sexual selection should be considered as a particular type of natural selection. In fact, selection in favour of individuals with the best abilities to find their sexual partners is in principle the same as selection in favour of individuals with the best abilities to escape their enemies or to use their food effectively. The only reason we use the term sexual selection, but not escape selection or food-utilization selection, is that the former sometimes brings into existence colourful feathers in birds while the latter usually result in invisible adjustments of nervous system or of metabolic pathways.

It can also be argued, however, that Darwin introduced the term and the concept of sexual selection just to explain the existence of biological structures their origin cannot be explained by the process of natural selection. Reading the book „The descent of man and selection in relation to sex,“ (Darwin 1871) one quickly realizes that Darwin considered sexual selection as a process similar to, but distinct from, natural selection. Moreover, at least one basic difference exists between natural and sexual selection. The former can only be responsible for the origin of structures and behavioural patterns, which positively influence the fitness of the organism. The latter, as well as artificial selection, can sometimes negatively influence this parameter.

Terminological problems are not subjects which scientists usually enjoy to play with. However, in this case, making an exception might be useful. The reasons why differences in opinion on sexual selection cannot be settled, are really basic. Natural selection, the central term in modern theories of biological evolution, is understood in two different ways. Some people use

this term in the sense „nonartificial, native.“ Others use the word „natural“ in the meaning „caused by nature, by the biotic or abiotic factors of environment.“ Both are right. The fault lies with Charles Darwin. When he introduced the term sexual selection as the name for the process accompanying the competition among members of the same sex for mating opportunities, he failed to introduce a complementary term for all other forms of nonartificial selection. Instead, he continued to use the term natural selection (sometimes ordinary selection) in this context. Darwin probably did not realize, or at least did not explicitly state, that he started to use this old term in a new, more restricted meaning.

From a technical point of view, there is no problem in correcting evolutionary terminology. The term natural selection should stay reserved for its original purpose, as the general term covering all forms of nonartificial selection. There are no problems with its special form, sexual selection. For all other types of natural selection, a new term should be introduced. The term environmental selection would probably be suitable.

Knowing how often the absence of the term for environmental selection has been recognized and proper solution suggested might be interesting. It might be even more interesting to know why this solution has never been adopted.

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Neutral cage interactions in *Mus macedonicus* (Rodentia: Muridae): an aggressive mouse?

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Abstract Intrasexual encounters between captive wild-born mice were video-recorded and subsequently analysed. Both sexes performed highly agonistic interactions in which upright postures were dominant behavioural elements. The categories of agonistic behaviour associated with attacking, fighting or chasing were more represented in male-male interactions than in those female-female. On the other hand, females spent more time by introductory behaviour and also by amicable behaviour. In spite of the above facts, the high level of female aggression in *Mus macedonicus* should be emphasized.

Agonistic behaviour, female aggression, behavioral ecology, wild mice, *Mus macedonicus*

INTRODUCTION

Mus macedonicus Petrov et Ružić, 1983, is a strictly outdoor species of mouse inhabiting the south of the Balkan Peninsula (e. g., Orsini et al. 1983, Bonhomme et al. 1984, Vohralík & Sofianidou 1987, 1992), as well as the large territories of the Middle East (e. g., Kratochvíl 1986, Auffray et al. 1990, Orlov et al. 1992). Despite its large distribution area it was recognized as a distinct species first in 1980s, and therefore, only a few studies concerning the population biology (e. g., Vohralík et al. 1996) and behaviour (Frynta et al. 1992, Frynta 1994) of this species have been published.

According to our experience with captive *M. macedonicus*, they seem to be unusually aggressive. It is nearly impossible to establish a stable group consisting of a few unfamiliar individuals. Interactions of unfamiliar mice are regularly accompanied with strong violence. Due to this phenomenon, it is usually difficult even to form a new breeding pair. Our attempts to establish heterosexual pairs, e. g., 50 pairs in September 1988, resulted frequently in serious wounding or even death of the subordinate individual. Sometimes, e. g., stimulated by cage cleaning, the aggression appeared after the seemingly peaceful period.

The aims of this study were 1) to assess the level of intraspecific aggression in *M. macedonicus*, and 2) to compare behavioural patterns performed in male-male and female-female encounters. The study is part of a research program involving comparative studies of aggressive behaviour in Palaearctic murids (Frynta et al. 1995, Čiháková & Frynta 1996, Munchlinger 1996). For this purpose, a simple procedure of dyadic encounters in neutral cage permitting quantification of the behavioural elements in a standardised test was adopted. This procedure is widely used in the studies of rodent behaviour, and despite some limitations (see the Discussion) it remains a useful tool for comparative studies (e. g., Montgomery 1978: *Apodemus sylvaticus* versus *A. flavicollis*, Cassaing 1990: *Mus domesticus*, *M. spretus* and *M. spicilegus*).

MATERIALS AND METHODS

Experimental animals were captured near the Krumovo village (SE Bulgaria) in September 1988. They were initially housed in heterosexual pairs. However, strong fights resulted in separation or even death of the subordinate animal. Each standard cage (42×22×22 cm) contained sawdust bedding, nesting material (hay) and shelters. Ad libitum water and food (DOS2b mouse and rat breeder diet, wheat etc.) were provided.

18 males and 8 females of *Mus macedonicus* were included in the investigations. At the time of testing, they were adult (overwintered) and sexually mature, males with testes in scrotal position. Despite their sexual maturity, females were actually neither pregnant nor lactant.

Encounters between mice were carried out in a 50×30×35 cm glass cage. The cage was divided by a thick card partition into two equal parts. During testing, the cage was illuminated by a single 40 W red light bulb suspended in the distance of approximately 1.5 metres. Mice were tested during the dark phase of their light-dark cycle (LD 14:8). At the beginning of each experimental session, two mice were placed in the pen, on the opposite sides of the partition, and left for five minutes. The central partition was then removed and video recording by a single VHS-camera started. The video camera was stopped at the end of the session, i.e., ten minutes after the moment when one or both animals paid attention to the other for the first time. After each session the cage was thoroughly cleaned using 96% ethanol.

In total, 18 male-male and 8 female-female encounters were performed. Each animal was tested with different opponents two times. Repeated testing of the same individual occurred no earlier than 24 hours after the preceding test. No effect of multiple testing was evident.

Tab. 1. Mean duration (in seconds) of different behavioural categories. n = number of dyads. Means are calculated per encounter. Asterisks indicate significant comparisons ($P < 0.05$).

	Females n = 8	Males n = 18	Mann-Whitney P
threat-attack	29.5	70.87	0.0225*
chase	0.00	8.18	0.0323*
roll-over fight	1.85	10.57	0.0083*
upright postures	215.12	297.41	0.4873
ambivalent	29.06	49.54	0.1484
avoid-retreat	16.91	35.06	0.4205
flee-jump-freeze	1.65	13.72	0.0343*
submissive	0.00	5.22	0.3674
AGONISTIC	323.84	490.54	0.0902
(S.E.)	(67.95)	(48.52)	
attend	11.04	25.11	0.0955
approach	41.55	38.81	0.5597
nose	133.69	43.38	0.0709
INTRODUCTORY	186.28	107.29	0.0486*
(S.E.)	(43.31)	(12.76)	
mutual groom	13.23	0.97	0.0826
body contact	19.04	0.09	0.0068*
AMICABLE	32.26	1.07	0.0427*
(S.E.)	(16.48)	(0.91)	
self groom	122.46	123.04	0.7180
crouch-sit	259.55	162.37	0.1735
INDIVIDUAL	382.01	285.42	0.2323
(S.E.)	(65.91)	(33.93)	
loco-explore	200.03	223.95	0.4874
rear-jump	75.59	91.73	0.4204
EXPLORATORY	275.61	315.68	0.5229
(S.E.)	(31.56)	(30.07)	

We distinguished 33 behavioural elements adopted with minor changes from Gurnell (1977) and Montgomery (1978), for description see Čiháková & Frynta (1996), which were summarised into 17 categories (Roman numerals) and 5 functional blocks.

(A) Agonistic (I) Threat-attack, (II) Chase, (III) Roll-over fight, (IV) Upright postures (Box, Neutral upright, Defensive upright and/or threat), (V) Ambivalent (to-from and/or tail-rattle), (VI) Avoid-retreat, (VII) Flee-freeze (including jump-avoid), (VIII) Submissive

(B) Introductory: (I) Attend, (II) Approach, (III) Nose.

(C) Amicable (I) Mutual groom, (II) Body contact (i. e., lie on, crouch under/over, block)

(D) Individual (I) Self groom, (II) Crouch-sit.

(E) Exploratory (I) Loco-explore, (II) Rear-jump

Video records of the encounters were subsequently observed and analysed. The observed behavioural elements were quantified using the computer program package ACTIVITIES (Vrba & Donát 1993). Data on total duration of each of these elements for a particular session and animal were used as the primary data for further analysis. Duration was expressed in seconds.

The data obtained in males and females were compared using the two-tailed Mann-Whitney test.

RESULTS

Both sexes spent considerable proportion of time by agonistic behaviour (Fig. 1, Table 1). In a typical case mutual upright postures (mostly defensive) of both opponents were predominant. Also the representation of ambivalent behaviour was high. There were only few chase-flee sequences, most attacks resulted in a defence, but not fleeing. Sexual differences were not apparent. However, agonistic behaviour was the most represented functional block of behaviour in males (41% of time), whereas females spent slightly, but not significantly ($P=0.09$), less time (27%) by this behaviour. The situation becomes more clear when the individual behavioural categories are compared: roll-over-fight ($P=0.0083$), threat-attack ($P=0.0225$), chase ($P=0.0323$) and flee-jump-freeze ($P=0.0343$) were significantly more represented in male-male interactions than in those female-female.

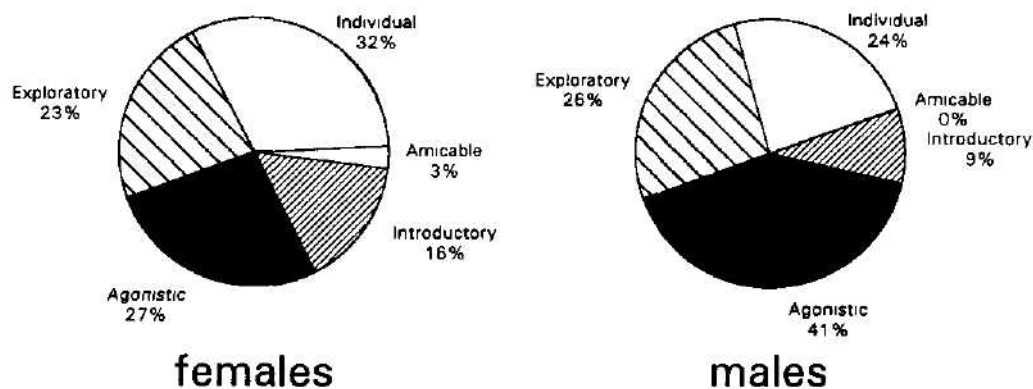


Fig. 1 Percentage of time spent in different types of behaviour in male-male (right) and female-female (left) encounters of *Mus macedonicus*.

Significant sexual differences were found also in two other functional blocks of behaviour. Females spent more time by introductory behaviour ($P=0.0486$) and also by amicable behaviour ($P=0.0427$), which was poorly represented in females (3% of time), but nearly absent in males (less than 0.1%).

DISCUSSION

Male aggression has a considerable effect on population structure in house mice (Crowcroft & Rowe 1963, Zegeren 1980). However, in contrast to the extensive literature about commensal mice, there are only a few studies dealing with the social behaviour in European species of aboriginal mice (Cassaing & Croset 1985, Sokolov et al. 1990, Hurst et al. 1994, 1996). Comparative studies showed high variation in the level of aggression among mice species (Zegeren & Oortmersen 1981, Cassaing 1990, Munclinger 1996). It may indicate corresponding variation in social and possibly also mating systems.

Behavioural patterns displayed by male *Mus macedonicus* in our experiments suggest high level of aggression, e. g., they spent more than two times more time by agonistic behaviour, when compared with *Mus domesticus* in similar experiments performed by Munclinger (1996).

Surprisingly, not only males, but also females of *Mus macedonicus* were highly aggressive. The phenomenon of female aggression was repeatedly described in house mice (e. g., Hood 1988, Brain & Parmigiani 1990, Parmigiani & Palanza 1994). However, female aggression towards conspecifics (especially adult females) is restricted either to the lactation period and pup defence or to the cohabitation with a territorial male (Brain & Parmigiani l. c.). Therefore, most studies performed in both commensal and aboriginal species of the genus *Mus* (e. g., Cassaing 1990, Munclinger 1996) reported only low levels of female-female aggression in the neutral-cage conditions.

Considering the extreme male aggression in *Mus macedonicus*, female aggression in this species can be simply explained by the genetic correlation of this character between sexes (Hood & Cairns 1988). No matter to its cause, however, the high representation of agonistic behaviour in female-female encounters probably interacts with social and/or mating system in this species.

The relevance of simple laboratory experiments to natural situation is a matter of discussion. It is obvious that behavioural interactions are situation specific. The results of laboratory studies of aggressive behaviour are dependent upon the presence of scent marks, rearing conditions, prior experience and other environmental factors (e. g., Hood & Cairns 1989, Brain & Parmigiani 1990, Hurst 1993). On the other hand, as clearly demonstrated in laboratory mice, a considerable component of this behaviour is inherited and can be altered by an artificial selection (Cairns et al. 1983, Gariépy et al. 1988, Cairns et al. 1990).

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Composition and seasonal changes of soil nematode community in a South Bohemian meadow

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Abstract. Diversity, abundance and seasonal changes of a soil nematode community were studied in a South Bohemian meadow in 1986–1987. A total of 109 species were found, *Pungentus thornei* Goodey, 1943, *Aporcelaimellus obtusicaudatus* (Bastian, 1865) + *A. obscurus* (Thorne et Swagner, 1936), *Eudorylaimus centrocerus* (de Man, 1880), *Filenchus vulgaris* (Brzcki, 1963), *Cephalobus persegnis* Bastian, 1865 and *Rhabditis maupas* Scurat in Maupas, 1910 group were the most abundant nematodes. Mean abundance of the total nematode community was $1.22 \times 10^6 \text{ m}^{-2}$, mean biomass 1.56 g m^{-2} . Omniphages and bacteriophages dominated in abundance, omniphages and predators in biomass.

Diversity, community composition, seasonal changes, meadow, Central Europe, soil nematodes

Grassland biome covers approximately $24 \times 10^6 \text{ km}^2$ on the Earth's surface which is about 16% area of continents and islands and represents a very diverse group of ecosystems (Rychnovská et al. 1985) inhabited by specific microorganisms, flora and fauna. Holocene Central Europe was mostly woodland territory but human population cleared large areas and changed them into settlements, cultivated fields or meadows. Those changes affected populations of soil organisms, including nematodes and modified diversity of their assemblages. Soil nematodes can significantly influence energy and nutrient cycling in grasslands, therefore, scientists pay a considerable attention to the composition and variation of their communities throughout the World (Overgaard-Nielsen 1949, Wasilewska 1979, Scott 1979, Yeates 1984, Solovyeva 1986, Hodda & Wanless 1994, and others).

In the Czech Republic soil nematodes of meadow ecosystems were studied at several localities. Leláková-Dušková (1964) investigated nematode fauna in a wet meadow near Plzeň, Háněl (1993) studied nematodes in a cultivated meadow in Central Bohemia and Háněl (1994a) described the composition and seasonal changes of nematode community in a 13-year old fallow. There are also data on species composition and abundance of a meadow nematode assemblage in the Krkonoše Mountains (Háněl 1994b). This paper concerns diversity, abundance and seasonal changes of soil nematodes in a humid meadow at the Chelčice village in South Bohemia.

MATERIAL AND METHODS

Investigations were carried out in a humid meadow in South Bohemia, Chelčice village, $49^{\circ}06'N$, $14^{\circ}07'E$, 570 m a.s.l., square code 6851 in the network of squares on the map of the Czech Republic for faunistic research. Long-term mean annual air temperature in the region is $7.3^{\circ}C$, precipitation 602 mm. Seasonal changes of air temperature and precipitation in 1986–1987 were published by Háněl (1994c). Seasonal changes of soil temperature (measured at about 10–11 a.m. in the depth of 5 cm) and soil moisture in 0–5 cm and 5–10 cm (expressed in percentage of water in wet soil dried at $105^{\circ}C$ for 4 hrs.) at individual sampling dates are shown in Fig. 1. Mean soil temperature was $10.1^{\circ}C$ in 1986 and $9.0^{\circ}C$ in 1987. Mean soil moisture in 1986 and 1987 was 26.6% and 30.5% in 0–5 cm, and 19.1% and 24.0% in 5–10 cm, respectively.

The plot was previously a cultivated field fallowed in 1975 and 1977 years, and then developed to a meadow till 1985. Since 1986 mowing was stopped, and the plot was left to undisturbed succession again. In both 1986 and 1987 years, *Holcus lanatus* L., *Holcus mollis* L., *Lathyrus pratensis* L., *Prunella vulgaris* L., and some other species dominated here. In 1987, the meadow was partially flooded in spring. Soil type is a silt loam cambisol, 7.0% clay, 41.0% sand, pH (H₂O) 5.5, humus form mull, C_{org} in 0–5 cm 2.6%, in 5–10 cm 1.9%. Soil samples were taken in approximately monthly intervals in April–December 1986 and in April–December 1987 using a cylindrical corer with an area of 1 cm² (inner diameter 1.2 cm) in 10 replicates down to the depth of 10 cm. Soil samples were divided into 0–5 cm and 5–10 cm subsamples. Nematodes were isolated from soil by means of the modified Baermann funnel method for 24 hrs. Animals were fixed by hot FAA, temporary and permanent mounts were made by the glycerol-ethanol method (Šály 1983). All nematodes in samples were counted and identified simultaneously.

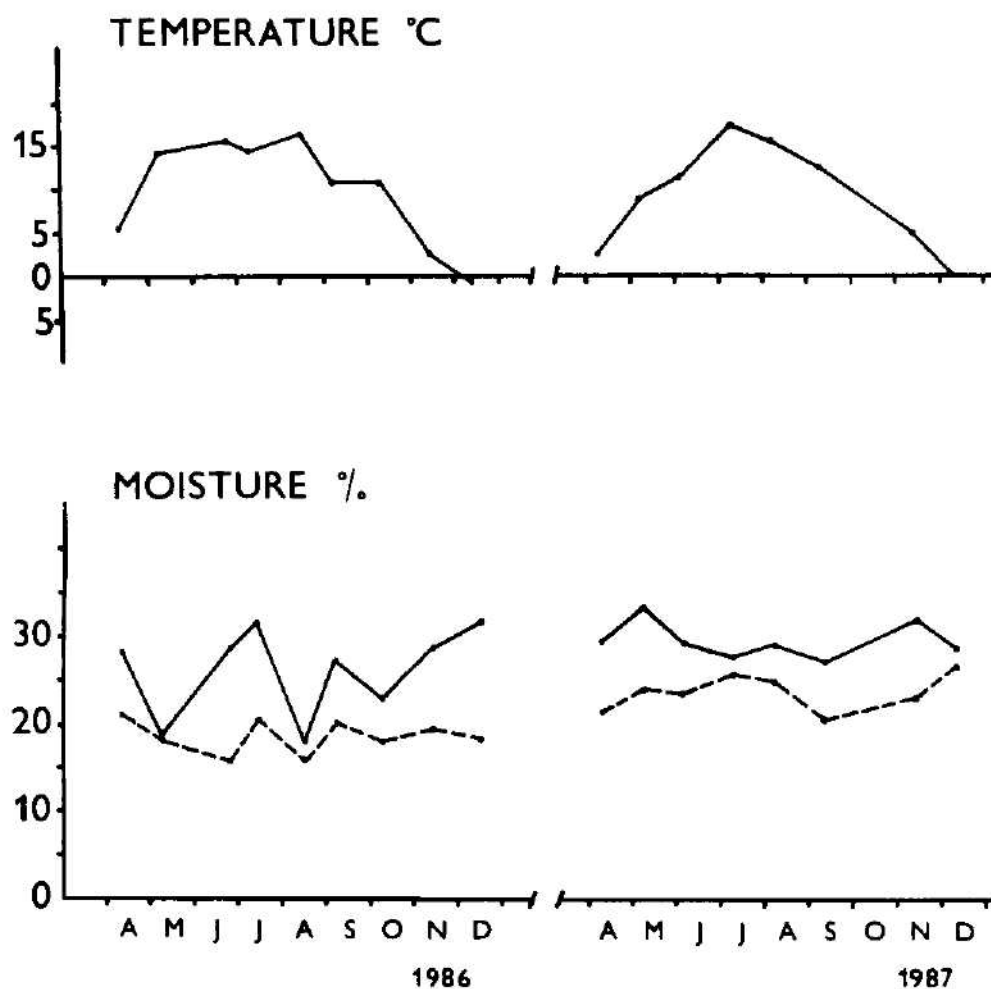


Fig. 1. Seasonal changes of soil temperature and moisture (full line, 0–5 cm, dashed line, 5–10 cm).

Nematodes were divided into trophic (ecological) groups as follows: bacteriophages (species 1–37, 75–77, 80–83 in Tab. 1), mycophages/myco-phytophages (fungal + facultative plant feeders) (38–45, 47–55, 58–61, 74), phytophages (56, 57, 62–73), omniphages (90–109), predators (46, 78, 79, 84–89). As concerns the group mycophages/myco-phytophages, representatives of the order Aphelenchida in the discussed meadow were mycophagous whereas those of the order Tylenchida are also known to feed upon higher plants (Yeates et al. 1994). The methods of nematode diversity and biomass estimates, correlation, cluster analysis and characteristic species combination are described in a paper by Háněl (1994c). The total material studied was about 21 000 individuals. The nematode material is deposited with the author at the Institute of Soil Biology AS CR.

RESULTS

A total of 109 species of nematodes were found in the soil of the meadow studied. Six (seven) species, *Pungentus thornei*, *Aporcelaimellus obtusicaudatus* + *A. obscurus*, *Eudorylaimus centrocerus*, *Filenchus vulgaris*, *Cephalobus persegnis* and *Rhabditis maupasi* group, dominated in both years. *Paratylenchus projectus* was dominant in 1986 and *Anaplectus granulatus* dominated in 1987, too. There were 23 species in the characteristic species combination of the community in 1986 and 18 species in 1987 (Tab. 1). The mean value of the species diversity H' index was higher in 1986 (3.62) than in 1987 (3.45).

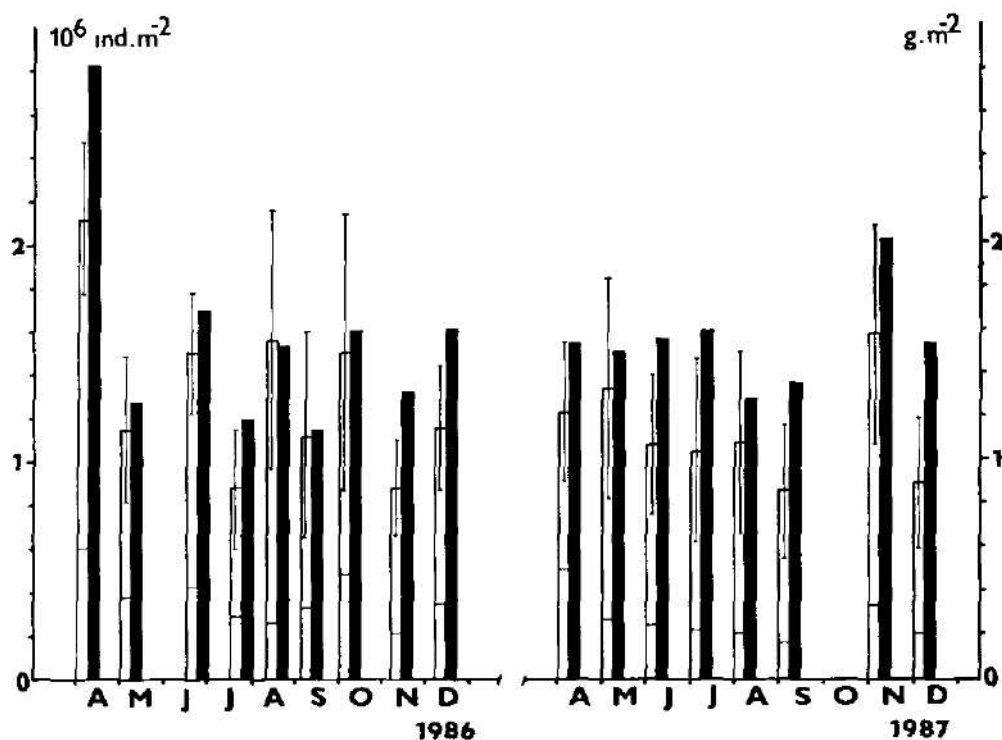


Fig. 2 Seasonal changes of abundance (white bars) and biomass (black bars) of nematodes, upper part of the white bars is the abundance in the soil layer of 0–5 cm, under part in the layer of 5–10 cm, abscissas – confidence limits ($P=0.05$)

Tab. 1 Mean abundance ($\times 10^3 \text{ ind. m}^{-2}$) of soil nematodes in meadow, bold – constant species (C 50–100%)

	1986	1987
order: MONHYSTERIDA		
1. <i>Eumonhystera vulgaris</i> (de Man, 1880)	2.1	20.1
2. <i>Eumonhystera longicaudatula</i> (Gerlach et Riemann, 1973)	–	0.3
3. <i>Geomonhystera villosa</i> (Bütschli, 1873)	0.1	–
order: ARAEOLAIMIDA		
4. <i>Cylindrolaimus bambus</i> Andrassy, 1968	–	0.1
5. <i>Anaplectus granulosus</i> (Bastian, 1865)	43.8	65.5
6. <i>Plectus acuminatus</i> Bastian, 1865	5.6	17.1
7. <i>Plectus aquatilis</i> Andrassy, 1985	–	2.9
8. <i>Plectus cirratus</i> Bastian, 1865	5.5	2.1
9. <i>Plectus geophilus</i> de Man, 1880	0.7	0.8
10. <i>Plectus longicaudatus</i> Bütschli, 1873	11.0	9.3
11. <i>Plectus parietinus</i> Bastian, 1865	5.0	23.5
12. <i>Plectus parvus</i> Bastian, 1865	5.3	9.1
13. <i>Plectus rhizophilus</i> de Man, 1880	13.1	10.3
14. <i>Plectus sambesi</i> Micoletzky, 1915	0.7	0.3
15. <i>Plectus silvaticus</i> Andrassy, 1986	3.0	15.4
16. <i>Plectus</i> Bastian, 1865 sp.	12.0	–
17. <i>Ceratoplectus armatus</i> (Bütschli, 1873)	4.9	1.0
18. <i>Wilsonema otophorum</i> (de Man, 1880)	0.2	+
19. <i>Tylocephalus auriculatus</i> (Bütschli, 1873)	–	0.1
order: TERATOCEPHALIDA		
20. <i>Metateratocephalus crassidens</i> (de Man, 1880)	0.9	0.6
21. <i>Teratocephalus paratenus</i> Eroshenko, 1973	0.1	–
22. <i>Teratocephalus terrestris</i> (Bütschli, 1873)	0.2	–
order: RHABDITIDA		
23. <i>Heterocephalobus elongatus</i> (de Man, 1880)	19.2	13.6
24. <i>Heterocephalobus longicaudatus</i> (Bütschli, 1873)	0.3	0.3
25. <i>Heterocephalobus loofi</i> Andrassy, 1968	–	0.7
26. <i>Cephalobus persegui</i> Bastian, 1865	65.6	60.8
27. <i>Cephalobus</i> Bastian, 1865 sp.	7.1	–
28. <i>Eucephalobus oxyuroides</i> (de Man, 1876)	58.2	44.0
29. <i>Eucephalobus striatus</i> (Bastian, 1865)	19.7	8.1
30. <i>Eucephalobus</i> Steiner, 1936 sp.	0.1	–
31. <i>Acrobeloides nanus</i> (de Man, 1880)	61.2	23.9
32. <i>Acrobeloides</i> (Cobb, 1924) sp.	–	0.4
33. <i>Panagrolaimus rigidus</i> (Steiner, 1866)	6.2	14.1
34. <i>Bursilla monhystera</i> (Bütschli, 1873)	8.4	3.5
35. <i>Rhabdites maupasii</i> group Seurat in Maupas, 1919	72.7	58.4
36. dauer larvae	0.6	–
order: DIPLOGASTERIDA		
37. <i>Diplogaster</i> Schultze in Carus, 1857 sp.	–	0.2
order: APHELENCHIDA		
38. <i>Aphelenchus avenae</i> Bastian, 1865	23.6	7.8
39. <i>Paraphelenchus pseudoparietinus</i> (Micoletzky, 1922)	0.2	0.9
40. <i>Aphelenchoides saprophilus</i> Franklin, 1957	+	–
and	10.7	4.0
41. <i>Aphelenchoides blastophthorus</i> Franklin, 1952	+	+
42. <i>Aphelenchoides composticola</i> Franklin, 1957	+	+

and		
43 <i>Aphelenchoides cyrtus</i> Paesler, 1957	+9.8	+10.2
44 <i>Aphelenchoides</i> Fischer, 1894 sp	+	
45 <i>Aphelenchoides minus</i> Meyl, 1953	0.4	0.2
46 <i>Seinura</i> Fuchs, 1931 sp	0.6	0.1
order TYLENCHIDA		
47 <i>Filenchus cylindricus</i> (Thorne et Malek, 1968)	—	0.4
48 <i>Filenchus discrepans</i> (Andrássy, 1954)	19.9	3.5
49 <i>Filenchus helenae</i> (Szczygiel, 1969)	4.0	2.1
50 <i>Filenchus minutus</i> (Cobb, 1893)	44.3	4.9
51 <i>Filenchus polyhypnus</i> (Steiner et Albin, 1946)	23.1	6.3
52 <i>Filenchus vulgaris</i> (Brzeski, 1963)	69.1	62.3
53 <i>Filenchus</i> (Andrássy, 1954) sp	2.6	—
54 <i>Lelenchus leptosoma</i> (de Man, 1880)	—	0.1
55 <i>Tylenchus ritae</i> Siddiqi, 1963	0.8	0.9
56 <i>Aglenchus agricola</i> (de Man, 1884)	15.7	8.5
57 <i>Costenchenus costatus</i> (de Man, 1921)	2.4	0.5
58 <i>Malenchus acarayensis</i> Andrássy, 1968		
and	2.4	2.9
59 <i>Malenchus andrassyi</i> Merny, 1970		
60 <i>Psilenchus terextremus</i> Hagemeyer et Allen, 1952	3.0	0.1
61 <i>Boleodorus innuptus</i> (Andrássy, 1961)	24.6	7.6
62 <i>Bitylenchus dubius</i> (Butschli, 1873)	0.3	0.1
63 <i>Helicotylenchus dihystra</i> (Cobb, 1893)	0.9	—
64 <i>Helicotylenchus pseudorobustus</i> (Steiner, 1914)	1.1	0.6
65 <i>Rotylenchus fallorobustus</i> Sher, 1965	56.9	17.0
66 <i>Pratylenchus crenatus</i> Loof, 1960	22.1	7.0
67 <i>Heterodera</i> Schmidt, 1871 sp	0.1	—
68 <i>Meloidogyne</i> Goeldi, 1892 sp	0.3	—
69 <i>Paratylenchus microdorus</i> Andrássy, 1959	5.7	—
70 <i>Paratylenchus projectus</i> Jenkins, 1956	80.1	23.3
71 <i>Macropasthonia ornata</i> (Raski, 1952)	6.6	0.3
72 <i>Nothocriconema</i> De Grisse et Loof, 1965 sp	—	0.1
73 <i>Ditylenchus</i> (Filipjev, 1936) sp 1	5.4	21.1
74 <i>Neoditylenchus</i> Meyl, 1961 sp	0.1	—
order ENOPLIDA		
75 <i>Bastiana gracilis</i> de Man, 1876	0.1	0.5
76 <i>Prismatolaimus dolichurus</i> de Man, 1880	—	5.8
77 <i>Prismatolaimus intermedius</i> (Butschli, 1873)	3.1	0.8
78 <i>Tripyla affinis</i> de Man, 1880	—	1.0
79 <i>Tripyla filicaudata</i> de Man, 1880	22.7	33.4
80 <i>Alaimus meyl</i> Andrássy, 1961	—	0.1
81 <i>Alaimus parvus</i> Thorne, 1939	2.1	—
82 <i>Alaimus primitivus</i> de Man, 1880 6.5 8 4		
83 <i>Paramphidelus dolichurus</i> (de Man, 1876)	5.1	1.9
order MONONCHIDA		
84 <i>Clarkus papillatus</i> (Bastian, 1865)	2.2	5.9
85 <i>Prionchulus punctatus</i> (Cobb, 1917)	4.7	1.6
86 <i>Mylonchulus</i> (Cobb, 1916) sp	0.1	—
87 <i>Anatonchus tridentatus</i> (de Man, 1876)	50.9	37.5
order DORYLAIMIDA		
88 <i>Nygolaimus brachyuris</i> (de Man, 1880)	0.1	—
89 <i>Nygolaimus</i> Cobb, 1913 sp	0.1	—
90 <i>Prodorylaimus paralongicaudatus</i> (Micoletzky, 1925)	24.4	34.0

Tab 1 (continued)

	1986	1987
91 <i>Mesodorylaimus bastiani</i> (Butschli, 1873)	16.8	25.9
92 <i>Eudorylaimus carteri</i> (Bastian, 1865)	0.9	—
93 <i>Eudorylaimus centrocerus</i> (de Man, 1880)	67.1	126.1
94 <i>Eudorylaimus parvus</i> (de Man, 1880)	1.0	0.1
95 <i>Eudorylaimus</i> Andrassy, 1959 sp.	3.9	7.3
96 <i>Thonus ettersbergensis</i> (de Man, 1885)	5.7	1.4
97 <i>Thonus</i> Thorne, 1974 sp.	2.4	—
98 <i>Dorydorella pratensis</i> (de Man, 1880)	0.1	1.3
99 <i>Aporcelaimellus obtusicaudatus</i> (Bastian, 1865)	+	+
and	69.1	64.6
100 <i>Aporcelaimellus obscurus</i> (Thorne et Swanger, 1936)	+	+
101 <i>Aporcelaimus eurydoris</i> (Ditlevsen, 1911)	—	0.3
102 <i>Pungentus thornei</i> Goodey, 1943	73.1	99.0
103 <i>Pungentus marietani</i> Altherr, 1950	0.2	0.1
104 <i>Oxydirus oxycephalus</i> (de Man, 1885)	10.2	9.1
105 <i>Axonchium coronatum</i> (de Man, 1906)	1.7	—
106 <i>Axonchium propinquum</i> (de Man, 1921)	42.2	46.9
107 <i>Dorylaimellus virginianus</i> Cobb, 1913	1.0	0.3
108 <i>Tylencholaimellus</i> Cobb in M. V. Cobb, 1915 sp.	28.4	16.6
109 <i>Diphtherophora</i> de Man, 1880 sp.	5.3	1.9

The mean abundance of the nematode community in 1986 and in 1987 was $1.31 \pm 0.26 \times 10^6$ ind.m⁻² and $1.13 \pm 0.17 \times 10^6$ ind.m⁻², respectively (Tab. 2). Seasonal changes of nematode abundance showed no prominent maxima or minima, the greatest population densities were found in April 1976 and in November 1987. Nematodes mostly inhabited upper parts of soil and in 1986 and 1987 71.3% and 76.7% of specimens were found in the layer of 0–5 cm, respectively. The adult specimens represented 37.3% (32.4–42.9%) of the nematode community in 1986 and 31.5% (24.4–37.1%) in 1987.

Seasonal changes of nematode abundance were significantly positively correlated with soil moisture in 0–5 cm ($r_p = +0.79$, $P = 0.05$) in 1987, whereas there was a insignificant negative correlation ($r_p = -0.29$) in 1986. The corresponding (insignificant) values in 5–10 cm were $r_p = -0.21$ and $r_p = +0.02$, respectively. No significant correlation was found between nematode abundance and soil temperature. Insignificant negative correlations were calculated between nematodes and precipitation ($r_s = -0.43$) and air temperature ($r_s = -0.31$) in 1987 whereas those in 1986 were positive ($r_s = +0.43$ and $r_s = +0.22$, respectively).

The mean biomass of the community in 1986 and in 1987 was 1.57 ± 0.33 g.m⁻² and 1.55 ± 0.15 g.m⁻², respectively, and the species *Aporcelaimellus obtusicaudatus* + *A. obscurus*, *Anatonchus tridentatus*, *Pungentus thornei* and *Eudorylaimus centrocerus* represented nematodes with the greatest individual biomass. The mean individual biomass of nematode specimen in the whole community was lower in 1986 (1.22 ± 0.13 g) than in 1987 (1.40 ± 0.15 g). Seasonal changes of community biomass mostly coincided with those of the abundance.

Two ecological groups dominated in 1986 and in 1987: omniphages (27.0% and 38.5% of the total abundance, respectively) and bacteriophages (33.5% and 37.5%). Omniphages represented 65.9% of the nematode biomass in 1986 and 69.4% in 1987. The biomass of predators was 22.3% in 1986 and 18.9% in 1987 (Tab. 2).

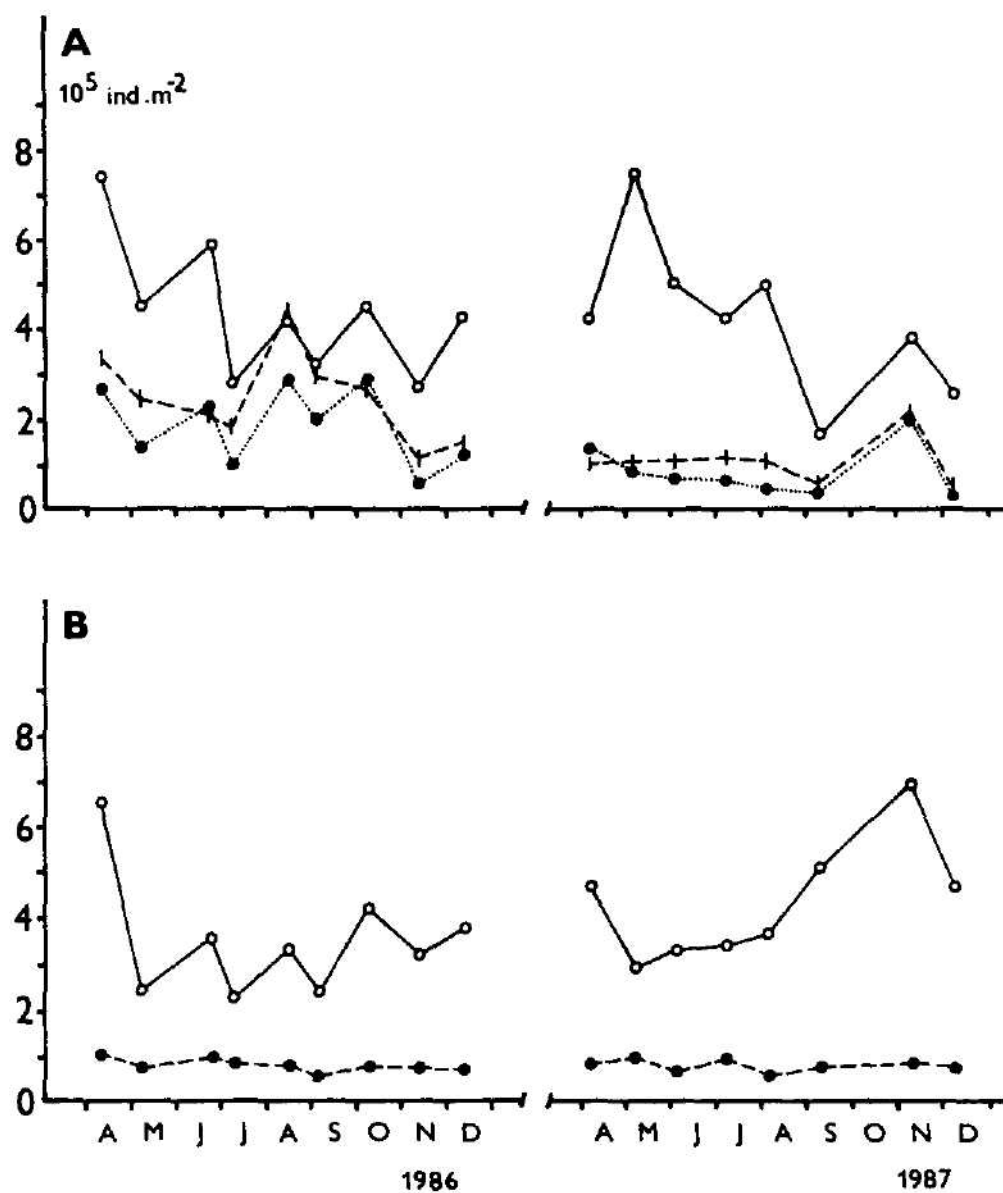


Fig. 3. Seasonal changes of abundance of ecological groups in nematode community. A: bacteriophages – solid line, mycophages/myco-phytophages – broken line, phytophages – dotted line. B: omniphages – solid line, predators – broken line

Tab. 2 Mean characteristics of soil nematode community in meadow. A – abundance (10^3 ind. m^{-2}), B – biomass (mg. m^{-2}), H' – index of diversity, CL – confidence limits ($P=0.05$)

	1986		1987	
	A	B	A	B
Bacteriophages	441	112	424	152
Mycophages/myco-phytophages	239	25	114	14
Phytophages	198	49	78	15
Omniphages	353	1034	436	1076
Predators	81	350	80	293
Total nematodes	1312	1570	1132	1150
± CL	±260	±330	±170	±150
% of adults	37.3		31.5	
number of species	94		87	
H'	3.62		3.45	

Seasonal changes of nematode trophic groups are shown in Fig. 3. The abundance of bacteriophagous nematodes gently declined from spring to autumn. Three genera were dominant in both 1986 and 1987 years as follows: *Cephalobus* (5.6% and 5.4% of the total nematode abundance), *Eucephalobus* (6.0% and 4.7%) and *Rhabditis* Dujardin, 1845 (5.6% and 5.2%, respectively). The genus *Acrobeloides* dominated in 1986 (4.7%), the genera *Plectus* and *Anaplectus* De Coninck et Sch. Stekhoven, 1933 in 1987 (8.0% and 5.8%, respectively).

Mycophagous nematodes + facultative plant feeders reached high population densities in April 1986, August 1986 and November 1987. The most abundant genus was *Filenchus* (12.5% and 7.0%).

The abundance of phytophages fluctuated during 1986 to decline in the period April – September 1987, then increased in November and fell down in December again. Only the genus *Paratylenchus* Micoletzky, 1922 dominated in 1986 (6.6%).

The first peak of omniphages abundance was observed in April 1986, then the population densities of Dorylaimida fluctuated till September – November 1987 when their abundance increased. The dominant omniphagous genera were *Aporcelaimellus* Heyns, 1965 (5.3% and 5.7%), *Eudorylaimus* s. l. (6.2% and 12.0%) and *Pungentus* Thorne et Swanger, 1936 (5.6% and 8.8%).

Population densities of predators were almost constant during the two years of investigations, the genus *Anatonchus* (Cobb, 1916) represented 3.9% and 3.3%, the genus *Tripyla* Bastian, 1865 1.2% and 3.1% of the total nematode abundance in 1986 and 1987, respectively.

Dendrograms of cluster analysis in Fig. 3 show that the generic composition of nematode assemblage in 1986 was different from that in 1987. The visualized differences were mainly due to mycophagous and phytophagous species whereas the population densities of predators and bacteriophages were almost equal in both consecutive years (Tab. 2)

DISCUSSION

Nematodes in the meadow studied represented a diverse community. Šály (1983) recorded 165 species of nematodes at 40 localities in Slovakia and at individual stands the number of species was lower than in the studied meadow. Wasilewska (1976) found 74 species of nematodes in a

meadow near Warsaw, Hodda & Wanless (1994) determined 154 species in chalk grasslands in England. A great number of nematode species (144–174) inhabited various meadows in Karelia (Solovyeva 1986), too. In the Czech Republic, Lelláková-Dušková (1964) determined 22 species in a wet meadow in South-West Bohemia, Háněl (1993, 1994a) found 57 species in a cultivated meadow in Central Bohemia and 81 species in a dry fallow in South Bohemia. A high number of species (87) was also in a Krkonoše Mts meadow, however, only two species (*Paratylenchus microdorus* and *Aglenchus agricola*) represented 59% of the total abundance (Háněl 1994b) and the equitability of the nematode community was lower than the species number and their equitability in lowland or highland meadows.

The abundance of nematodes in the investigated meadow was relatively low but the biomass was proportionally high. Lelláková-Dušková (1964) estimated the abundance in a range from 0.9 to 3.9×10^6 ind. m⁻². Wasilewska (1979) gives the mean value for grassland nematode abundance in Poland 2.8×10^6 ind. m⁻² (biomass 1.7 g. m⁻²), Solovyeva (1986) found the abundance in the meadows of the European part of the former Soviet Union 1.1 – 3.4×10^6 ind. m⁻² and the biomass 1.8–5.4 g. m⁻². Ricou (1979) in Cook et al. (1992) estimated the nematode abundance in French pastures from 1.5 to 55.0×10^6 ind. m⁻² and biomass from 0.4 to 2.2 g. m⁻². Those differ

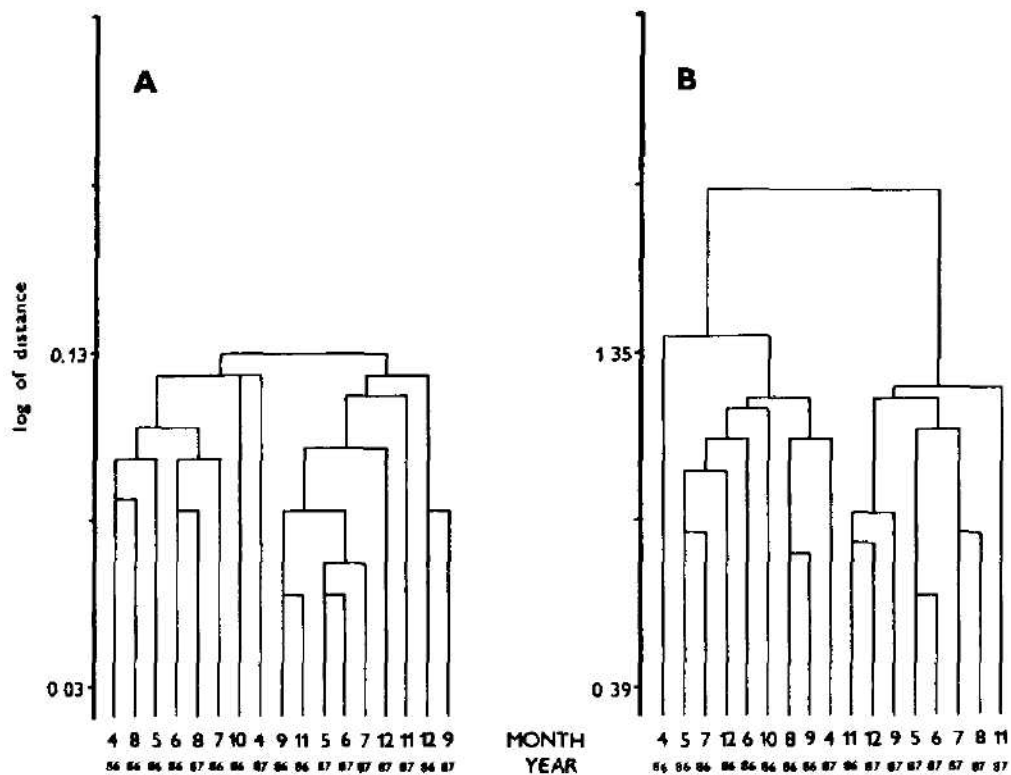


Fig. 4 Cluster analysis of soil nematodes. A: genera presence. B: log(x+1) genera abundance.

ences can be explained by a different composition of nematode communities. For example, Wasilewska (1979) gives the abundance of omniphages (pantophages) $0.7 \times 10^6 \text{ ind m}^{-2}$ and that of phytophages $1.1 \times 10^6 \text{ ind m}^{-2}$. A high abundance of nematodes in grasslands usually reflects population densities of the phytophages and the omniphages represent a greater part of the biomass. In the meadow studied, the abundance of phytophages was low (especially in 1987) and, consequently, the abundance of the total nematode community as well.

Seasonal fluctuations of nematode abundance in the meadow studied were mostly insignificant. Similar changes were also recorded in the dry fallow which is about 1 km distant from the meadow. On the other hand, nematodes in a mountain meadow in Krkonoše Mts. underwent significant abundance changes from 0.3 to $5.7 \times 10^6 \text{ ind m}^{-2}$. The range of nematode abundance fluctuations in different meadows can be caused by a lot of abiotic and biotic factors, unfortunately, recently available data are not sufficient to support a concise hypothesis on that phenomenon. Nevertheless, it seems to be true that nematode annual cycles in grasslands may be better correlated with plant production than with soil moisture and temperature which have a direct effect on plant production (Yeates 1984).

The studied meadow represented a humid stand, the fallow a dry one, but the quantitative parameters of nematode assemblage in the fallow (abundance $1.09 \times 10^6 \text{ ind m}^{-2}$, biomass 1.37 g m^{-2} , mean individual nematode biomass 1.29 g , 31.3% of adult specimens) were similar to those in the meadow. The nematode diversity (number of species, H' spp) was higher in the meadow than in the fallow (81 species, H' spp=3.11) and these differences could be a result of a different water supply in the compared sites (meadow in a shallow depression, fallow at a terrace on a gentle slope). It is known that soil moisture can significantly influence the composition of nematode communities in meadow ecosystems (Solovyeva 1986, Wasilewska 1991). In the meadow studied there were remarkable changes in proportions among nematode populations of different feeding habits which appeared during the year 1987 (Fig. 3). The abundance and dominance of bacteriophages decreased whereas those of omniphages increased, and the abundance of phytophages + mycophages was lower than in 1986. This phenomenon was probably caused by abundant precipitation in winter 1987 which resulted in meadow flooding in spring and a high soil moisture during the year (Fig. 1). European Dorylaimida are probably better adapted to swampy soils than Tylenchida, for example Gagarin (1981) recorded numerous species of Dorylaimida in freshwater biotops of the European part of the former Soviet Union but Tylenchida were absent there, Wasilewska (1991) documented increase in the abundance of Tylenchida with the drainage of peat soils, etc. A lot of Dorylaimida species can also feed upon plants (Yeates et al. 1993) and probably compete with Tylenchida at some localities. However, their life cycles are longer than those of Tylenchida which could explain their delayed abundance increase in autumn 1987. The decrease in the abundance of the bacteriophages since spring to autumn (Fig. 3) probably reflected litter decomposition. Stable population densities were in carnivorous nematodes as the dominant predators, *Anatonchus tridentatus* and *Tripyla filicaudata*, prefer wet stands and live in fresh water reservoirs.

The different water regime in consecutive years and its influence on nematode populations could also be reflected in negative correlation of soil (0–5 cm) moisture with nematode abundance in 1986 but a positive correlation in 1987. Unfortunately, nematode species requirements for soil moisture are poorly known in details, moreover, flooding in spring was likely accompanied by soil oxygen deficiency, changes in root production of different plant species and their succession, variations in population densities of nematode predators (other than nematodes) and parasites, etc.

Generally, the soil nematode community in the meadow studied in 1986–1987 represented a complicated heterogeneous system which was able to maintain a sufficiently stable diversity, abundance and biomass (Tab. 2) irrespectively it underwent detectable structural changes (Fig. 4). Those structural changes could be connected with variations in soil water content. It is a very difficult question to answer why the nematode community was so resilient to this kind of stress. An explanation (besides those discussed above) could consist in a stable abundance of predaceous nematodes, the positive effect of predators on animal community diversity was discussed by, e. g., Paine (1966). As the dominant predators were well adapted to moisture variation their role in the control of nematode populations was probably not negatively affected. However this suggestion may be problematic, studies on biological qualities of individual nematode species deserve more attention than they were paid to till now.

SUMMARY

1. Species composition, diversity, trophic structure and seasonal changes of a soil nematode community were studied in a meadow in South Bohemia in 1986–1987.
2. A total of 109 species were found, *Pungentus thornei*, *Aporcelaimellus obtusicaudatus* + *A. obscurus*, *Eudorylaimus centrocerus*, *Filenchus vulgaris*, *Cephalobus persegnis* and *Rhabditis maupasi* group were dominant nematodes in both years. *Paratylenchus projectus* dominated in 1986, while *Anaplectus granulosus* in 1987.
3. Mean nematode abundance was $1.22 \times 10^6 \text{ m}^{-2}$, the proportion of adult specimens was about 34.4%. Seasonal changes of the nematode community were marked by no distinct maxima or minima. The mean biomass of nematode community was 1.56 g.m^{-2} .
4. Bacteriophages and omniphages were the most abundant trophic group of nematodes, omniphages and predators had the greatest biomass.

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The relationship between thermal constants for insect development: a verification

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Abstract. The existence of a negative relationship between lower development threshold (LDT) and sum of effective temperatures (SET) established earlier (Honěk & Kocourek 1990) was examined using data for 463 species and subspecies of 14 insect orders. The results were concordant with earlier conclusions. The linear regressions of LDT on SET were negative and statistically significant for 12 of twenty data sets for particular development stages and orders represented by >10 populations. For total development the negative LDT/SET relationship was significant for 7 orders represented by >10 populations. For combined data of all Insecta, significant negative LDT/SET relationship was found in eggs and pupae. For larvae and total development the relationship was not significant due to variation of average SET between orders. Weighted averages of the slopes of different orders predicted a 2.3 °C, 1.1 °C, 2.9 °C and 2.0 °C decrease of LDT per 100 day degrees increase of SET in eggs, larvae, pupae and total development, respectively. The sources of the scatter of the data decreasing the significance of the results are discussed.

Development threshold, effective temperatures, egg, larva, pupa, growth, adaptation

INTRODUCTION

Temperature is an important factor of development time in insects. Over a range of ecologically significant temperatures, development rate (a reciprocal of development time) increases linearly with temperature. Assuming the linear development rate/temperature relationship, we may calculate thermal constants for the development: lower development threshold LDT which is a temperature at which the development ceases, and sum of effective temperatures SET which is the total of heat units (day degrees above LDT) needed to complete the development. In fact, the relationship is nonlinear at low temperatures near to LDT and at high temperatures which become harmful to the organism. However, over the range of ecologically significant temperatures the development rate may be calculated using linear development rate/temperature relationship. It enables an easy prediction of the length of development under a variety of conditions including natural course of weather.

Earlier we have demonstrated (Honěk & Kocourek 1988) the negative relationship between thermal constants of development for a group of aphid predators. In a particular development stage, LDT decreased with increasing SET. Similar though more diffuse results were obtained with a large set of data retrieved from literature and naturally burdened by much „noise“. The negative LDT/SET regressions calculated for egg, larval, pupal and total development were statistically significant for seventeen of 21 sets of data for particular orders where n was greater than 10 (Honěk & Kocourek 1990). The negative LDT/SET relationship results from the fact that regression lines for development rate plotted over temperature intersect above LDT, within the range of ecologically relevant temperatures. Recently, Trudgill (1995) proposed a functional explanation for the negative LDT/SET relationship. Of two species the one with lower LDT and greater SET develops faster at low temperatures below the intersection point of regression lines

while the one with higher LDT and smaller SET develops faster at higher temperatures above the intersection point. One may predict a tendency for decreasing LDT and increasing SET with increasing geographic latitude. While the first consequence appears trivial the second prediction is unexpected. In fact, the data retrieved from published information, however biased by a serious „noise“, revealed statistically significant tendencies coherent with these predictions (Honěk 1996).

In this paper I verify the earlier conclusions (Honěk & Kocourek 1990) concerning LDT/SET relationship on an independent set of data and discuss the causes of great scatter of published values of thermal constants.

MATERIAL AND METHODS

Lower development threshold LDT and sum of effective temperatures SET were recalculated from literature data on duration of nondormant development at constant temperatures. The data were retrieved from literature. No attempt at assorting the data was made to prevent a subjective selection of results in favour of the hypothesis. LDT and SET were calculated using data on development duration at temperatures 28 °C or 80 °F, in thermophilic species with LDT > 16 °C from temperatures 32 °C, using the linear relationship

$$1/D = aT + b$$

where D is duration of development or its particular stage (days), T is temperature (°C), a the slope and b the intercept of linear regression. From here $LDT (°C) = b/a$, and $SET (day\ degrees\ dd) = 1/a$

A linear regression of LDT on SET was calculated for particular development stages and total development, using data for different orders and total Insecta. Average slope for combined data of particular development stages was also calculated as weighted mean (by number of cases for each order) of slopes for different orders. This procedure partly eliminated the effect of orderspecific differences in SET. The aphids were considered separately of other Homoptera due to their viviparity

RESULTS

The regression of LDT on SET was calculated using data for 463 species and subspecies of 14 insect orders (Appendix). The negative LDT/SET relationship was established in all development stages and orders except the eggs of Thysanoptera (Tab. 1). Average LDTs for eggs, larvae and pupae were similar while average SETs were typical for different development stages.

In eggs, negative LDT/SET relationship was statistically significant in 7 of 13 orders (Tab. 1). The slopes of significant regression lines (in orders where number of investigated populations was $n > 10$) predicted a 1.7 °C (Hymenoptera) to 4.1 °C (Heteroptera) decrease of LDT per 100 dd increase of SET. The cumulative plot of data for all orders ($n = 383$, $r^2 = 0.084$, $p < 0.05$) predicted a 1.3 °C decrease of LDT per 100 dd increase of SET (Fig. 1). Weighted average of the slopes of different orders predicted a 2.3 °C decrease of LDT per 100 dd increase of SET.

In larvae, negative LDT/SET relationship was established in particular orders but not in the cumulative plot of data for all orders (Tab. 1). The relationship was statistically significant in 5 of 12 orders, in Neuroptera and Orthoptera the results remained below the limit of statistical significance due to small n. The slopes of significant regression lines (in orders with $n > 10$) predicted a 0.7 °C (Lepidoptera) to 4.9 °C (Aphidoidea) decrease of LDT per 100 dd increase of SET (Fig. 2). The plot of cumulative data for all orders did not reveal a significant LDT/SET relationship, due to large differences in SET between the orders (Tab. 1). Weighted average of the slopes of different orders predicted a 1.1 °C decrease of LDT per 100 dd increase of SET.

In pupae, negative LDT/SET relationship was significant in all orders (Tab. 1). The slopes of regression lines (in orders with $n > 10$) predicted a 1.5 °C (Diptera) to 3.7 °C (Coleoptera) decrease of LDT per 100 dd increase of SET. The cumulative plot of data for all orders ($n = 391$, $r^2 = 0.241$, $p < 0.001$) predicted a 2.6 °C decrease of LDT per 100 dd increase of SET (Fig. 1).

Tab. 1. Average (\pm SE) lower development thresholds (LDT, $^{\circ}$ C), sums of effective temperatures (SET, dd), coefficients of determination (r^2), slopes of regressions of LDT on SET ($a \times 10^2$, i. e. $^{\circ}$ C decrease of LDT per 100 dd increase of SET), and slopes of regressions calculated by Honěk and Kocourček (1990) ($a^* \times 10^2$, only for sets where $n > 10$ and $p < 0.05$); * = significant at $p < 0.05$

	n	LDT mean \pm SE	SET mean \pm SE	r^2	a ($\times 100$)	a* ($\times 100$)
EGGS						
Aphidoidea	4	7.2 \pm 0.6	94.7 \pm 3.7	0.587 ^a	-12.4	
Coleoptera	118	11.7 \pm 0.3	86.5 \pm 6.6	0.129 ^a	-1.9	-2.8
Dermoptera	1	13.1	109.0			
Diptera	44	8.7 \pm 0.4	52.4 \pm 6.5	0.013	-0.7	-5.8
Ephemeroptera	6	3.6 \pm 0.7	357.2 \pm 48.9	0.010	-0.1	
Heteroptera	51	11.6 \pm 0.5	116.8 \pm 6.5	0.273 ^a	-4.1	-1.9
Homoptera	31	13.5 \pm 0.4	105.1 \pm 5.8	0.091	-1.8	
Hymenoptera	12	11.0 \pm 0.9	114.1 \pm 41.3	0.565 ^a	-1.7	
Lepidoptera	92	10.1 \pm 0.3	89.1 \pm 5.9	0.111 ^a	-1.8	-5.2
Neuroptera	6	10.4 \pm 1.8	63.1 \pm 11.7	0.870 ^a	-14.3	-12.7
Odonata	3	13.1 \pm 0.7	176.6 \pm 18.4	0.999 ^a	-3.7	
Orthoptera	7	12.3 \pm 1.9	343.6 \pm 50.6	0.519	-2.7	
Siphonaptera	1	6.2	42.3			
Thysanoptera	7	8.2 \pm 1.0	88.7 \pm 16.4	0.009	0.5	
Total	383	10.8 \pm 0.2	98.9 \pm 4.2	0.084 ^a	-1.3	
LARVAE						
Aphidoidea	43	5.2 \pm 0.5	127.0 \pm 6.0	0.402 ^a	-4.9	-2.3
Blattodea	4	13.0 \pm 0.5	3883.6 \pm 250.7	0.978 ^a	-0.2	
Coleoptera	126	13.8 \pm 0.4	305.5 \pm 12.8	0.001	-0.1	-0.7
Dermoptera	1	17.2	457.8			
Diptera	57	8.5 \pm 0.5	156.9 \pm 15.9	0.263 ^a	-1.7	-2.9
Heteroptera	55	12.0 \pm 0.3	272.0 \pm 15.0	0.009	-0.2	-2.2
Homoptera	38	12.2 \pm 0.5	236.2 \pm 19.9	0.263 ^a	-1.3	
Hymenoptera	18	11.0 \pm 0.8	201.4 \pm 25.2	0.215	-1.5	
Lepidoptera	167	10.1 \pm 0.3	364.9 \pm 15.6	0.271 ^a	-0.7	-1.3
Neuroptera	6	12.1 \pm 2.0	148.9 \pm 20.1	0.275	-5.3	
Orthoptera	10	17.9 \pm 0.7	542.6 \pm 63.8	0.379	-0.7	
Thysanoptera	8	7.8 \pm 0.7	150.3 \pm 16.5	0.117	-1.4	
Total	533	11.0 \pm 0.2	309.4 \pm 15.6	0.000	0.03	
PUPAE						
Coleoptera	120	12.9 \pm 0.4	92.9 \pm 5.4	0.286 ^a	-3.7	-5.1
Diptera	75	9.1 \pm 0.4	100.9 \pm 7.4	0.091 ^a	-1.5	-1.4
Hymenoptera	30	10.6 \pm 0.7	113.0 \pm 10.8	0.279 ^a	-3.4	
Lepidoptera	158	10.5 \pm 0.3	158.0 \pm 5.8	0.327 ^a	-2.5	-1.3
Neuroptera	6	11.2 \pm 1.9	121.7 \pm 30.8	0.880 ^a	-5.8	-2.6
Siphonaptera	2	11.3 \pm 0.1	208.2 \pm 14.6	1.000	-0.5	
Total	391	11.0 \pm 0.2	123.3 \pm 3.7	0.241 ^a	-2.6	
TOTAL DEVELOPMENT						
Aphidoidea	43	5.20.5	127.0 \pm 6.0	0.402 ^a	-4.9	-2.3
Blattodea	4	12.4 \pm 0.4	4894.3 \pm 280.5	0.983 ^a	-0.2	
Coleoptera	124	14.6 \pm 0.4	441.4 \pm 15.1	0.077 ^a	-0.8	
Dermoptera	1	16.9	549.8			
Diptera	76	9.5 \pm 0.3	237.3 \pm 14.9	0.075 ^a	-0.5	-0.9
Heteroptera	53	12.0 \pm 0.4	382.3 \pm 17.7	0.081 ^a	-0.6	
Homoptera	33	12.8 \pm 0.5	326.9 \pm 22.4	0.207 ^a	-1.0	
Hymenoptera	117	11.4 \pm 0.3	227.3 \pm 9.3	0.226 ^a	-1.7	
Lepidoptera	117	9.6 \pm 0.3	545.7 \pm 23.8	0.183 ^a	-0.5	-0.8
Neuroptera	6	11.7 \pm 2.0	329.7 \pm 50.0	0.851 ^a	-3.7	-3.6
Orthoptera	3	17.5 \pm 0.9	893.4 \pm 187.1	0.988	-0.5	
Siphonaptera	1	11.4	404.2			
Thysanoptera	8	7.6 \pm 0.8	268.6 \pm 23.3	0.006	-0.3	
Total	581	11.2 \pm 0.2	389.9 \pm 18.0	0.000	-0.01	

Weighted average of the slopes of different orders predicted a 2.9 °C decrease of LDT per 100 dd increase of SET.

For total development, negative LDT/SET relationship was statistically significant in 9 of 12 orders (Tab. 1), i. e. in all orders with $n > 10$ and two less represented ones. The slopes of significant regression lines (in orders with $n > 10$) predicted a 0.5 °C (Lepidoptera) to 1.7 °C (Hymenoptera) decrease of LDT per 100 dd increase of SET (Fig. 3). The plot of cumulative data for all orders did not reveal a significant LDT/SET relationship, due to large differences in SET between the orders (Tab. 1). Weighted average of the slopes of different orders predicted a 2.0 °C decrease of LDT per 100 dd increase of SET.

DISCUSSION

The results confirmed the existence of the negative regression of lower development threshold LDT on sums of effective temperatures SET (Honěk & Kocourek 1988, 1990), however, the slopes calculated for particular orders were mostly different (Tab. 1). The differences originated from the large scatter of LDT and SET data which prevented an accurate calculation of LDT/SET relationship.

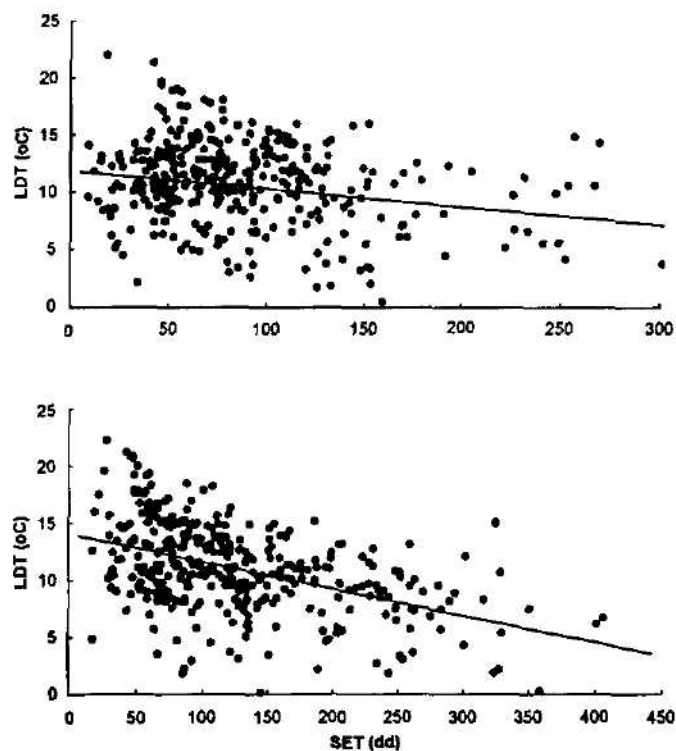


Fig. 1. The common plot LDT on SET for eggs and pupae, combined data of all Insecta.

The scatter may have several sources. (a) The most important source of „noise“ are perhaps the differences in estimation of development length caused by variation of methods. (b) Auto-correlation between LDT and SET (which both are calculated using the slope of the same regression of development rate on temperature) may also contribute to negative LDT/SET relationship. Suppose calculating LDT and SET for species with identical thermal requirements. Errors in estimating development length of a population will cause variation in slope and intercept of regression lines calculated for different replicates. Thermal constants LDT and SET calculated of this series of regression lines will be negatively correlated. Distinguishing autocorrelation from biological variation between species is an unresolved problem (B. D. Frazer personal com-

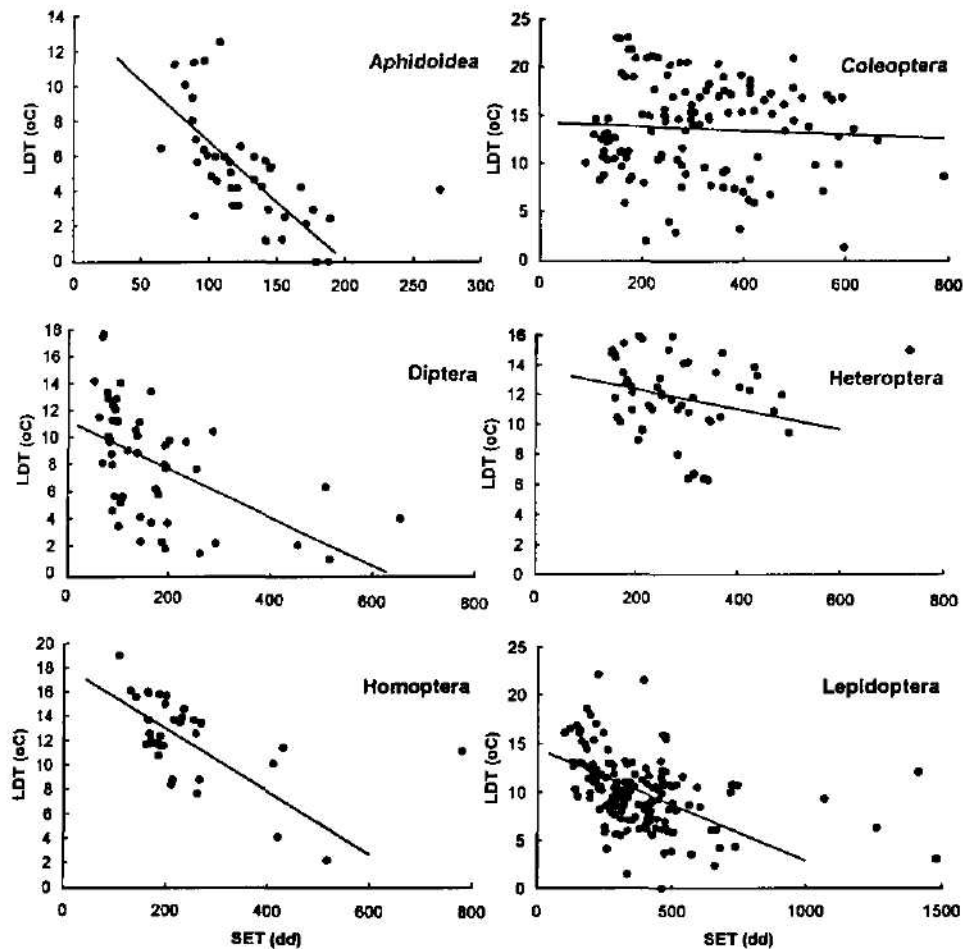


Fig. 2. The plots of LDT on SET for larvae of selected orders. Outliers with high SETs were not included in calculating regression lines. The lines are plotted over intervals of SET for which they were calculated.

munication). (c) Including data for populations with some kind of development arrest may also increase the scatter. Data for some populations with very high SETs which appear as outliers in LDT/SET plots (Figs 2 and 3) may originate in this way. (d) Using different types of food may increase the scatter of data for larvae and total development. To obtain data close to an ideal LDT/SET regression will require keeping optimum trophic and humidity conditions for all included populations. (e) Body size or a ratio of final larval to original (egg) size is probably an important determinant of development length. Selecting groups of species with similar body size would probably decrease the scatter along SET axis. (f) Consistence of data may be increased by selecting groups of species with similar biology. The large importance of this selec-

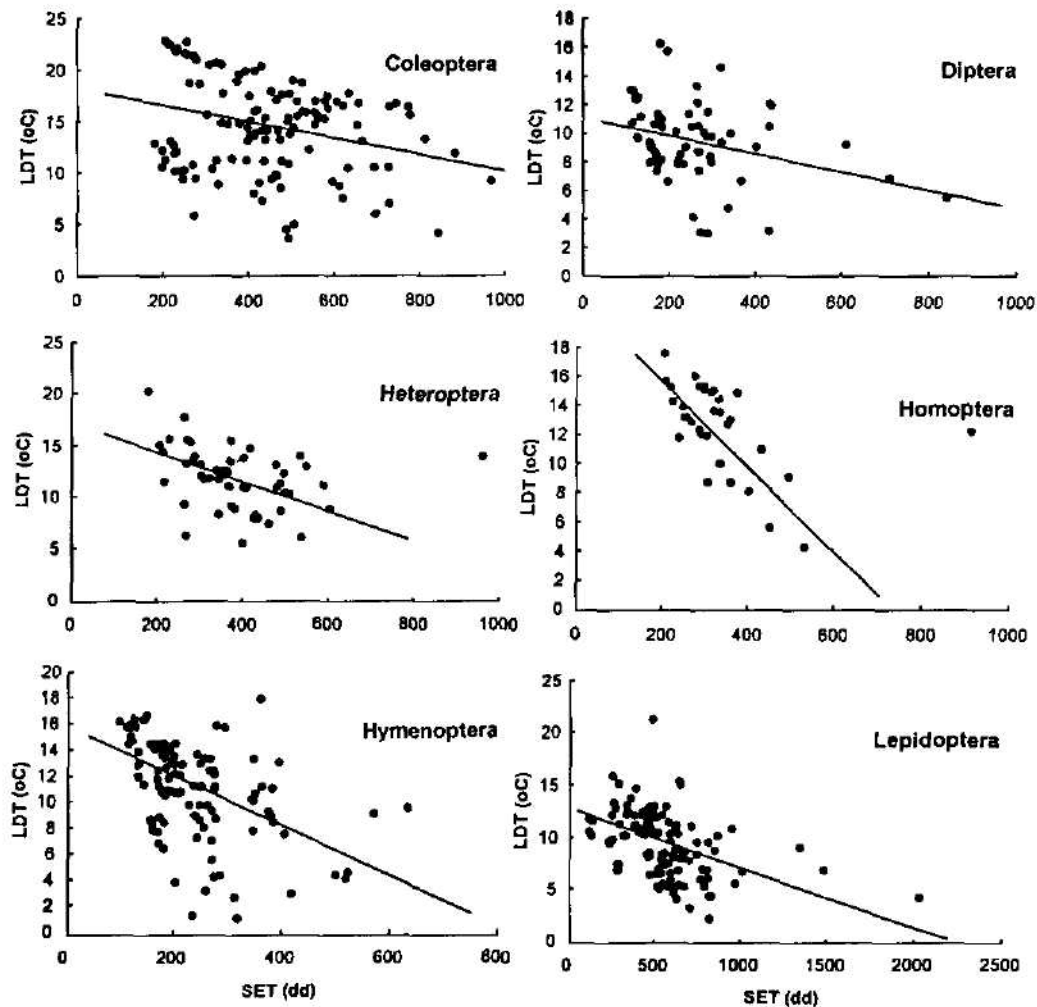


Fig. 3. The plots of LDT on SET for total development of selected orders. Outliers with high SETs were not included in calculating regression lines. The lines are plotted over intervals of SET for which they were calculated.

tion may appear from comparing data for larval and total development (Figs 2 and 3) in taxa with uniform ecological requirements (e. g. sucking plant sap feeders Aphidoidea and Homoptera) where the data are close to LDT/SET regression, and groups with a diversified larval biology (e. g. Coleoptera) where regression relationship it is loose.

The large scatter of data and variation in slopes of regression lines indicate the need for further research which may reveal the geographic, taxonomic and ecological variation in LDT/SET relationship. Further development may be done in two directions: (i) „purification“ of secondary data gathered from literature. The scatter of data may be decreased by excluding data suspect to be wrong. Honěk (1996) used only the data for species where development length was measured in >4 temperatures. Another method is excluding these species where development rate/temperature regressions have broad confidence limits (Honěk, Jarošík & Janáček in prep.). (ii) More rewarding is establishing comparative experiments with using identical method of estimating development lengths.

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APPENDIX

Lower development threshold LDT and sum of effective temperatures SET for populations included in this study. The last column indicates factors that diversified the response of populations of the same species and caused intrapopulation variation of thermal constants: D developmental differences (number of instars, wing polymorphism), G genetic differences, H humidity, P photoperiod, T trophic factors, M males, F females. Otherwise the data represent different populations of the same species.

Genus	Species	Egg		Larva		Pupa		Total		Reference	
		LDY	SET	LDY	SET	LDY	SET	LDY	SET		
Aphidoidea											
Acyrtosiphon	kondoi Sharp			5,7	115,4			5,7	115,4	Kodel et al 1982	P
				3	143,8			3	143,8	Kodel et al 1982	
				6	104,7			6	104,7	Kodel et al 1982	
Acyrtosiphon	pisum (Harris)			2,6	155,7			2,6	155,7	Rohrha and Penman 1983	
				6,1	98,4					Lamb and MacKay 1988	
				5,4	95,7					Lamb and MacKay 1988	
				8,4	96,1					Lamb and MacKay 1988	
				5,7	91,5			5,7	91,5	Ben et al 1983	
Adeges	prossa (Ratzeburg)	8,6	92,1							Amman 1968	H
		5,1	99,4							Amman 1968	H
		7	103,2							Amman 1968	H
Aphis	craccivora Koch			3	176,8			3	176,8	Radke et al 1973	P
				4,3	167,9			4,3	167,9	Radke et al 1973	P
				4,3	139,1			4,3	139,1	Radke et al 1973	P
Aphis	fabae (Sopoli)			6	112			6	112	Tatejima and Mittler 1976	
Aphis	gossypii Glover			7	90,1			7	90,1	Knoosrek et al 1994	
				1,2	142,1			1,2	142,1	Aldhyim and Khalil 1993	
				6,5	64,6			6,5	64,6	Steens & El-Khawass 1995	T
				12,6	107,1			12,6	107,1	Steens & El-Khawass 1995	T
Aphis	neri Boyer de Fonscolombe			11,3	74,1			11,3	74,1	Groeters 1992	
				10,1	82,1			10,1	82,1	Groeters 1993	
				9,4	87,4			9,4	87,4	Groeters 1994	
Diuraphis	noxa (Mordvilko)			5,5	146,1			5,5	146,1	Girma et al 1990	T
				8	133,2			8	133,2	Girma et al 1990	T
				5,4	145,3			5,4	145,3	Girma et al 1990	T
				2,5	188,7			2,5	188,7	Michels and Behle 1980	
Longistigma	liquidambarus (Takahashi)			4,2	270,1			4,2	270,1	Kawada 1993	
Macrosiphum	euphorbiae (Thomas)			0	187,7			0	187,7	Barlow 1962	
				0	178,5			0	178,5	Bessolov 1988	
Metopolophium	dirhodum (Walker)			0	179,6			0	179,6	Zhou and Carter 1992	
				4,2	116,7					Cannon 1984	D
				4,9	101,4					Cannon 1984	D
Myzus	persicae (Sulzer)			2,8	89,7			2,8	89,7	Barlow 1962	
				4,2	121			4,2	121	El-Din 1978	
				1,3	153,8			1,3	153,8	Kuo 1991	
				3,2	117,9			3,2	117,9	Kuo 1991	
Rhopalosiphum	maidis (Fitch)			4,6	106,1			4,6	106,1	Elliott et al 1988	
				5,1	116,2			5,1	116,2	Elliott et al 1988	
Rhopalosiphum	nymphesae (L.)			4,7	133,4			4,7	133,4	Nasser and Mohamed 1993	
Rhopalosiphum	padi (L.)			3,2	122,1			3,2	122,1	Sengonca et al 1994	
Schizaphis	graminum (Rondani)			8,1	87,5			8,1	87,5	Kirkland et al 1981	
Sitobion	avenae (F.)			2,2	171,4			2,2	171,4	Sengonca et al 1994	
Toxoptera	citricidus (Kirkaldy)			11,5	95,5			11,5	95,5	Takanashi 1989	
				11,4	88,1			11,4	88,1	Takanashi 1989	
Vileus	vitifoliae (Fäch)	9,2	84,1							Belcan and Cognetti 1983	
Blattodea											
Periplaneta	fuliginosa (Serville)	5,2	1252,7							Benson et al 1994	
		5,4	1249,2							Benson et al 1994	
				14	3289,4			13,4	4234,0	Benson et al 1994	M
				13,8	3496,3			13,1	4457,1	Benson et al 1994	F
				11,8	4475,2			11,2	5563,6	Benson et al 1994	M
				12,5	4273,4			11,9	5322,8	Benson et al 1994	F
Coleoptera											
Acanthoscelides	obtectus (Say)	11,3	103,5							Lor and Fornasen 1983	
Adaka	bipunctata (L.)	7,5	48,3							Hamalainen & Markkula 1977	
		12,8	25,3	5,9	188,1	10,7	87,8	9,4	245,6	Olszak 1987	
		9	49,9							Frazer and McGregor 1992	
Alphitobius	diaperinus (Panzer)	14,9	84,6	17,7	324,9	15	81,5	17,2	461,2	Rueda and Adell 1986	
Anoplophora	malassaca (Thomson)	9,8	148,2			11,7	115,6			Adachi 1994	
Aphodius	limetarius (L.)	11,4	42,8	7,1	398,7	12,3	78,1	9,9	461,3	Christensen & Dobson 1977	
Aphthona	abdominalis (Dufschmid)	12,3	113,1							Fornasen 1995	
Artipus	floridanus Horn	11,1	151,5							Tarrant and McCoy 1989	
Bruchidius	incarnatus (Bohmann)	15,9	83,5	19	182					El-Kil and Mehwal 1971	H
		14,4	129,7	21	184	22,3	29			El-Kil and Mehwal 1971	H
						19,6	26,9			El-Kil and Mehwal 1971	H
Bubus	bison (L.)	7,2	189							Kirk and Kirk 1990a	
		7,3	189,5							Kirk and Kirk 1990b	
Calathus	melanocephalus (L.)					9	163,6			VanDyk 1994	T
						6,9	263,3			VanDyk 1994	T
Carabus	ysconinus Bates	5,6	151,1	1,5	597,5	5,7	157,3	4,4	844,2	Sota 1988	
Caronops	pumilio (Erichson)	14,5	72,8	14,8	107,9	12,4	231,7	13,7	402,1	Fletcher et al 1991	
Carpophilus	hemipterus (L.)	10,2	21,4	7,5	381,3	8,2	204,7	7,7	619,2	Cangardel 1981	
Carpophilus	lignaeus Murray	10,7	23,6	8,9	451,6	7,1	248,9	7,2	727,2	Cangardel 1981	
Cassida	rubiginosa Muller	11,7	89	11	236,7	11,3	69,2	11,3	394	Ward and Plenkowski 1978	
Chilocorus	bipustulatus (L.)	12	111,3	8	420	13,6	89,4	9,3	595,5	Podoler and Heneen 1983	

Genus	Species	Egg		Larva		Pupa		Total		Reference
		LDI	SET	LDI	SET	LDI	SET	LDI	SET	
Chilocorus	humanae Silverstein	11.9	90.9	8.7	322.4	14.2	64.1	11.2	475.5	Podoler and Hemen 1983
Chrysomela	populi L.	10.9	58.9	8	202.9	8.8	64.8	8.9	328.5	Loi and Belcan 1983
Cilithoalethrus	arcuatus (Rotsch)	2.8	92	10.4	131.5	13	59.5	10.8	269.5	Belkows et al 1992
Coccinella	californica Mannerheim	9.2	51.7							Frazer and McGregor 1992
Coccinella	septempunctata L.			2.9	265.7	12.9	60.7			Kawauchi 1979
		9.7	48.4							Frazer and McGregor 1992
		7.3	63.1							Hamalainen & Markkula 1977
Coccinella	infasciata L.	8.4	48.1							Frazer and McGregor 1992
Coccinella	undecimpunctata L.	9.5	50.2							Frazer and McGregor 1992
Coelopallorus	foveicollis (Blair)	14.3	74.8	16.7	438.5	15.5	77	16.4	582.5	Halstead 1967
Coelophora	quadrivittata Fauvel	12.8	31.8	13	105.5	12.7	43	12.9	180.2	Chazeau 1981
Collops	vittatus (Say)	15.4	76.9	19.3	363.5	14	90	18.9	522.2	Butler and Wardecker 1973
Coprus	hispanus (L.)	11.1	117							Kirk and Kirk 1990a
		10.4	127.9							Kirk and Kirk 1990b
Costelytra	zealandica (White)					3.2	262.2			Wightman 1971
		7.9	158.4							Wightman 1973
		5.7	241.6							Wightman 1973
Cryptolaemus	montgouzei Mulsant	10.8	58.1	14.5	244.7	12.3	109.5	13.7	411.2	Babu and Azam 1987
Cryptolestes	pusillus (Schoenherr)	13.8	87.2			15.7	64.2	15.7	300.1	Currie 1967
		15.3	40.3			15	73.1	14.5	503.7	Currie 1967
		14.7	84.1							Currie 1967
		14.7	51.2							Currie 1967
Cryptolestes	pusillus fuscus (Lefkovich)	14.2	60.8	15.4	368.9	15.6	64.4	15.4	488.8	Lefkovich and Currie 1967
		10.3	87.5	15.6	419.1	15.5	65.6	15.3	558	Lefkovich and Currie 1967
Cryptolestes	pusillus pusillus (Schoenherr)			14.7	330.9					Lefkovich and Currie 1967
				14.6	497.9					Lefkovich and Currie 1967
Cybocephalus	micans Reitter	13	120.3	14.7	132.5	12.7	260.4	13.8	494.5	Blumberg and Swinski 1982
Cybocephalus	nigripes nigripes (Sahlberg)	12	124.5	13.4	217.6	14.5	326.2	14.8	652.3	Blumberg and Swinski 1982
Cycloneda	poria Casey	10.2	42.1							Frazer and McGregor 1992
Dendroctonus	ponderosae Hopkins	8.5	81.3	7.8	334.5	9	71.5	8.6	472.8	Safaryuk and Whitney 1985
Dermestes	aler DeGeer			13	585.8	11.8	120.1			Coombs 1981
Dermestes	fructus (Kugelnann)	12.4	42.8			16.1	89			Amos 1968
						10.8	82.8			Amos 1968
						15.2	87.5			Amos 1968
				21.1	494.3					Amos 1968
				17.3	562.6			15.8	773.1	Amos 1968
				17.4	451.8			17.1	575.5	Amos 1968
				17.1	349.1			16.9	741.2	Amos 1968
				18.2	296			16.1	411.2	Amos 1968
Dermestes	haemorrhoidalis Kustlar	6.6	81.6	13.5	480.2	11.8	137.6	13.2	664.1	Coombs 1979
Dermestes	lardarius L.			10.1	585.5	8	148			Coombs 1979
						10.5	139.3			Fleming and Jacob 1986
Dermestes	peruvianus Laporte	9.2	62.5	12.6	661.7	10.6	175.9	12.1	882.2	Coombs 1979
Diabrotica	virgifera (LeConte)	4.2	690.7							Wilde 1971
Diabrotica	virgifera virgifera (LeConte)			10.7	235	10.7	104.7			Jackson and Elliott 1988
				9.9	277.6	10.8	108.9			Jackson and Elliott 1988
		10.8	253.6							Schaeffer et al 1991
Dytiscus	alascanus Balfour-Browne	4.7	126.5							Aiken 1986
Epischina	varveitzi Mulsant	8.6	98.2	7.6	278	9.3	90.3			Fan et al 1992
						0.2	144.3			McAvoy and Smith 1979
				3.3	392					Wilson et al 1982
		10.4	88.8			10.3	84.3			Meloni and Allegro 1984
Eriopis	connexa Mulsant	10.3	49.7	10.7	122.5	6.9	60.7	10.2	226.8	Miller and Paulsen 1992
Galeruca	sardoa (Géné)			9.2	358.5	10.3	98.8			Uscidda and Crovetti 1963
Gnathochilus	quadriguttatus (Say)	8.8	66	6.3	408.9	2.3	234.2	6.2	696.4	Mussen and Chiang 1974
Gnathochilus	maxillosus (F.)							18	449.8	Ntifo & Nowosielski-S 1973
								16	550.4	Ntifo & Nowosielski-S 1973
								16	531.5	Ntifo & Nowosielski-S 1973
								16.1	522.8	Ntifo & Nowosielski-S 1973
								15.7	556.7	Ntifo & Nowosielski-S 1973
								15.3	573.6	Ntifo & Nowosielski-S 1973
								14.8	553	Ntifo & Nowosielski-S 1973
								10.7	725.7	Ntifo & Nowosielski-S 1973
Harmonia	axydis Pallas			5.3	175	17.5	22.5			Kawauchi 1979
Hippodamia	convergens (Guénn-Ménéville)	9.7	50.2							Frazer and McGregor 1992
		10.1	45.7			8.3	77.7			Butler and Dickerson 1972
		11.2	42	13	125.9	12.6	58.2	12.7	224.7	Miller 1992
		11.6	38.1	13.2	131.2	13.6	49.2	13.1	216.7	Miller 1992
Hippodamia	parenthesis (Say)	9.6	43.4	10.5	145.8	10.3	61	10.3	249.8	Orr and Obyeki 1990
Hippodamia	quinqueguttata (Kirby)			12.7	145.8	11.2	79.2			Kaddou 1960
Hippodamia	sinuata Mulsant	9.3	38.1	8.6	179.8	9.7	53.8	9.5	274.8	Michels and Behle 1991
		13.3	24.7	12.4	134.9			12.1	231.1	Michels and Behle 1991
Hylodius	pales (Herbst)	9.4	105.7	7.3	555.8	10.1	329.2			Salem et al 1987
Hypera	males (F.)	9.7	115.1	10.8	425.8	10.3	91.2	10.6	531.4	Chan et al 1990
Ips	avulsus (Eichhoff)	10.5	41.8	12.5	119.7	11.8	38	12.2	197.8	Wagner et al 1988
Ips	caligraphus (Germar)	11	43.1	11.3	124.9	11.7	36.6	11.3	204.4	Wagner et al 1987

Genus	Species	Egg		Larva		Pupa		Total		Reference	
		LDT	SET	LDT	SET	LDT	SET	LDT	SET		
Trogoderma	granarium alium Presner	17.3	76.2	20.6	286.7	18.2	63.7	20	411	Badawi 1973	H,M
				20.5	347.2	17.7	57.5	20.5	426.6	Badawi 1973	H,F
		15.9	84.5	20.3	253.6	17.6	53.4	19.7	377.3	Badawi 1973	H,M
				20.6	272	17.6	49.6	20	389.5	Badawi 1973	H,F
		17.9	70	21.9	170.2	17.8	52.3	21.2	273.7	Badawi 1973	H,M
				21.3	217.9	16.7	53.3	20.8	322.7	Badawi 1973	H,F
		18.2	67.2	19.3	248.3	17.5	56.3	19	366.3	Badawi 1973	H,M
				21.1	228.3	17.9	49.5	20.6	334.2	Badawi 1973	H,F
				15	330					Hadaway 1955	H
				10	540					Hadaway 1955	H,M
				17	312					Hadaway 1955	H,F
				15.3	455					Hadaway 1955	H
				17.1	349.3					Hadaway 1955	H,M
				14	528					Hadaway 1955	H,F
Trogoderma	irroratum Reitter					12.3	67.1			Hadaway 1955	M
						15	60			Hadaway 1955	F
		14.4	109.2	17.1	591.5	11.3	82.5	16.6	769.3	Badawi 1973	H,M
		18.2	76.5	16.3	477.5	16.7	66.7	16.7	617.9	Badawi 1973	H,M
				18	495.6	16.7	60	17.9	631.2	Badawi 1973	H,F
		15.4	100.6	18.4	331.4	16.3	67.4	17.8	492.5	Badawi 1973	H,M
Trogoderma	vanzhile Bailon			18.2	410.5	12.8	84.5	17.6	580.6	Badawi 1973	H,F
		21.4	41.5	18.8	410.8	16.5	59.2	19.1	500.7	Badawi 1973	H,F
Trogoderma	versicolor (Cressler)			17.3	372.9					Elbert 1979	M
				19.1	358.5					Elbert 1979	F
Typhaea	stercoraria (L.)	14.7	98.8			15	60			Hadaway 1955	M
						12.5	76.6			Hadaway 1955	F
				17.4	371			17.1	510.2	Hadaway 1955	H,M
				17.4	452.2			17.1	602.6	Hadaway 1955	H,F
				17.4	410.8			17.1	552.9	Hadaway 1955	H,M
				13.8	614.7			13.5	811.7	Hadaway 1955	H,F
				17	514			16.9	654	Hadaway 1955	H,M
				16.6	572.7			16.6	726.7	Hadaway 1955	H,F
		13.1	45.1	14.2	312.1	14.9	46.1	14.9	377.2	Jacob 1968	H
Dermaptera											
Nala	lividipes (Dufour)	13.1	109	17.2	457.8			16.9	549.8	Simpson 1993	
Diptera											
Aedes	aegypti (L.)			13.4	71.1	10.9	32.8			Rueda et al 1990	
Aedes	dorsalis							11.2	127.8	Parker 1979	
Aedes	campestris Dyar & Knab			10.2	132.4	8.7	46.1			Tauthong and Brust 1977	
				8.9	134.9	12.4	32.9			Tauthong and Brust 1977	
Agromyza	frontella (Rondani)					7.7	289.8			Mellors and Helgesen 1982	
Anastrepha	ludens (Loew)	9.7	75.7			7.8	315.8	9.4	607.2	Leyva-Vazquez 1989	
Anastrepha	suspensa	10.5	43.6	11.3	83.3	9.6	121.1	10.5	249.2	Prescott & Baranowski 1971	
Atheropona	soccata Rondani							9.2	400	Delobel 1983	
Bactrocera	dorsalis (Hendell)	12.3	20.9	2.4	145.2	7.1	213.5	6.8	365	Yang et al 1994	
Boophilora	erythrocephala (DeGeer)					4.6	81.2			Prugel 1988	
Bradysia	impabens (Johannsen)	3	80.9	2.4	291.5	5.8	64	3.3	431.3	Wilkinson & Daugherty 1970	
Calliphora	alpina Zetterstedt					2.8	253.9			Davies and Ratcliffe 1994	
Calliphora	vicina Robineau-Oesvoldy					2.9	252.2			Davies and Ratcliffe 1994	
Ceratitis	capitata (Wiedemann)	10.7	33.3	11.2	136.8	11.7	152.8	11.6	284.4	Conli 1988	
		10.1	31.7	6.3	171.9	14.8	112.9			Shoukry and Halef 1979	
Chaoborus	flavicornis Meigen			1.4	515	7.3	42.9			Harazato and Yasuno 1989	
Chromatomyia	syngenesiae (Hardy)							8.8	264.4	Cheah 1967	M
								8.8	267.6	Cheah 1967	F
Cricotopus	bicinctus (Meigen)			3.8	165.5					Mackay 1977	
Cricotopus	syvestris (F.)			3.8	195.8					Mackay 1977	
Culex	annulirostris Skuse	8.9	32.2	7.8	250.6	16	19	10.2	277.5	Mottram et al 1986	
Culex	quadrfasciatus Say	10.4	25.9	10.6	128.4					AlFattal and Zaya 1996	
				11.2	92.8	9.3	31.3			Rueda et al 1990	
Culex	theileri Theobald			8.1	187.6	9	35.2			Linde et al 1991	G
								6.2	219.2	Linde et al 1991	G,M
								8.6	223.8	Linde et al 1991	G,F
				7.6	189.9	10.1	29.7			Linde et al 1991	G
								7.9	218.5	Linde et al 1991	G,M
								7.9	230.3	Linde et al 1991	G,F
Culex	tritaeniorhynchus Giles			12.4	83.5					Nakamura 1963	
				12.3	85.7					Nakamura 1963	
Culex	vishnu Theobald			12.9	89.8					Nakamura 1963	
Culicoides	mississippiensis Hoffman	6.5	94.5							Davis et al 1983	
				6.7	503.9			7.1	707.1	Davis et al 1983	D
				4.5	651			5.8	838.9	Davis et al 1983	D
						8	56.6			Davis et al 1983	G,M
						9.1	53			Davis et al 1983	C,F
						9.4	52.1			Davis et al 1983	C,M
						10.2	47.5			Davis et al 1983	C,F

Genus	Species	Egg		Larva		Pupa		Total		Reference		
		LOT	SET	LOT	SET	LOT	SET	LOT	SET			
Culicoides	varipennis (Coquillett)	10.1	34.9	9.8	227.5	10.4	33.4	9.9	296.6	Mullens and Rutz 1963		
Dacus	cucurbitae (Coquillett)					10	160.3			Nakamori et al 1978		
Dacus	oleae (Gmelin)	8.6	19.2							Shibata 1936		
		8.2	51.1							Crovetti et al 1961		
				12.1	87.7	9.7	186.4	12.2	261.4	Crovetti et al 1962		
		7.9	20.3							Taraspis 1977		
										Taraspis 1980		
Dasyneura	brassicae (Winnertz)			7.9	193.2	10.5	31.4			Aselsten 1992		
Delia	coarctata Fallén			1.6	260.2	8.1	134.6	7.5	266.8	Aselsten 1992		
Drosophila	lutescens Okada									Jones 1978		
Drosophila	melanogaster (Meigen)									Kimura et al 1994		
									7.9	152.4	Oudman et al 1990	G
									9.3	153.5	Oudman et al 1990	G
									9.3	154.2	Oudman et al 1990	G
									9	154.5	Oudman et al 1990	G
									9.1	153.8	Oudman et al 1990	G
									9.4	152.3	Oudman et al 1990	G
									9.4	150.1	Oudman et al 1990	G
									9.1	154.8	Oudman et al 1990	G
									9	155.8	Oudman et al 1990	G
									8.57	166.68	Barnes et al 1989	
									8.7	164.58	Barnes et al 1989	
									8.47	166.89	Barnes et al 1989	
									8.36	168.33	Barnes et al 1989	
									8.17	170.56	Barnes et al 1989	
									8.42	166.95	Barnes et al 1989	
									8.44	167.38	Barnes et al 1989	
									8.39	167.37	Barnes et al 1989	
									8.44	165.46	Barnes et al 1989	
									12.5	114.4	Delden and Kamping 1991	G
									13.1	108.3	Delden and Kamping 1991	G
									12.6	120.2	Delden and Kamping 1991	G
									13.1	104.9	Delden and Kamping 1991	G
									12.4	117.6	Delden and Kamping 1991	G
									13	111.1	Delden and Kamping 1991	G
									8.2	177.4	McKenzie 1978	
									11.4	241.5	Zwaan et al 1992	
				10.1	75.9						Partridge et al 1994	G
						9.4	69				Partridge et al 1994	G,M
				9.9	78.1						Partridge et al 1994	G
						9.7	65.5				Partridge et al 1994	G,M
				9.7	78.3						Partridge et al 1994	G
						9.4	60				Partridge et al 1994	G,M
				10	77.4						Partridge et al 1994	G
						10.1	62.3				Partridge et al 1994	G,M
						10.8	55.2				Partridge et al 1994	G,F
				9.9	78.1						Partridge et al 1994	G
						10.3	59.9				Partridge et al 1994	G,M
						10.6	54.6				Partridge et al 1994	G,F
				10	77.8						Partridge et al 1994	G
						10.5	58.8				Partridge et al 1994	G,M
						11	52				Partridge et al 1994	G,F
								9.1	236.1	Al-Safar et al 1995a		
		8.4	16.5							Al-Safar et al 1995b	H	
		6.2	20.9							Al-Safar et al 1995b	H	
		5.1	23.5							Al-Safar et al 1995b	H	
		5.5	24.2							Al-Safar et al 1995b	H	
		4.5	27.2							Al-Safar et al 1995b	H	
						8.1	66			Al-Safar et al 1995b	H	
						8.1	72			Al-Safar et al 1995b	H	
						7.5	77.2			Al-Safar et al 1995b	H	
						9	68.3			Al-Safar et al 1995b	H	
						9.4	67.2			Al-Safar et al 1995b	H	
						9.5	67			Al-Safar et al 1995b	H	
						9.1	71.5			Al-Safar et al 1995b	H	
						8.1	81.3			Al-Safar et al 1995b	H	
						8	85.3			Al-Safar et al 1995b	H	
Drosophila	mercatorum Peterson & Wheeler							3.1	288.1	Ikeda and Saito 1983	G	
								4.2	256.4	Ikeda and Saito 1983	G	
								3.2	273.7	Ikeda and Saito 1983	G	
Drosophila	prostipennis L.							8	151.5	Kimura et al 1994		
Drosophila	simulans Sturtevant							6.7	193.7	McKenzie 1978		
Drosophila	takahashii Sturtevant							9.8	121.6	Kimura et al 1994		
Drosophila	tritulae Bock and Wheeler							7.4	167.4	Kimura et al 1994		
Episyrphus	balticus (DeGeer)	6.7	30.5	2.4	188	6.1	123.9	4.9	334.2	Ankersmit et al 1986		
Gasterophilus	intestinalis (DeGeer)	10.9	85.9							Sukhapesna et al 1975		
Haematobia	imitans eximia deMeijere	9.2	14							Cook and Spain 1961		

Genus	Species	Egg		Larva		Pupa		Total		Reference	
		LD	SET	LD	SET	LD	SET	LD	SET		
<i>Haematobia</i>	<i>irritans exiguus deMejere</i>					11.1	108.5			Cook and Spain 1981	M
<i>Haematobia</i>	<i>irritans irritans (L.)</i>					11.1	98.4			Cook and Spain 1981	F
								10.2	212.3	Lysyk 1992	
								10.7	182	Palmer et al. 1981	
<i>Haematobia</i>	<i>irritans (L.)</i>	14.1	8.8	11.5	57					Depner 1961	
<i>Hippelates</i>	<i>bishoppi Sabrosky</i>	11.3	43	14.1	97.3	13	121.7	13.4	259.2	Karandinos and Astell 1967	
<i>Hippelates</i>	<i>callipes (Loew)</i>	9.3	37.5	17.7	60.8	12.2	114.8	16.3	172.8	Karandinos and Astell 1967	
<i>Hippelates</i>	<i>pusan (Loew)</i>	10.6	36.8	17.5	59.4	12.4	129	15.8	190.2	Karandinos and Astell 1967	
<i>Hylemya</i>	<i>brassicae (Bouché)</i>	5.4	46.8							Eckenrode and Chapman 1971	
<i>Hylemya</i>	<i>platana (Meigen)</i>	2.1	34.5	5.9	177	3.2	151			Sanborn et al. 1982	
<i>Linomyza</i>	<i>bryoniae (Kaltenbach)</i>	8.4	88.8	5.7	90.9	5.5	204.1			Lee et al. 1990	
		5.5	59	8.8	84.2	8.2	157.1	8.1	295.4	Minkenberg & Helderman 1990	
<i>Linomyza</i>	<i>trifoli (Burgess)</i>	10.9	35.4	8	85.9					Zoebsch et al. 1992	
		9.7	83.2	8.1	67.4	9.8	144.4	8.5	291.9	Estevaz 1985	
		10.8	46.1	12.9	73.8	7.8	154.5	10.6	264.1	Dimetry 1973	
<i>Linophaga</i>	<i>districae (Townsend)</i>							9.7	123.7	McPherson and Hensley 1978	
								10.8	110.2	McPherson and Hensley 1978	
<i>Mayetolia</i>	<i>destructor (Say)</i>	9.9	38.4	1.9	192.3	1.8	188.7			Foster and Taylor 1974	
<i>Megaselia</i>	<i>scalans (Loew)</i>	10.1	247.3	9.1	116					Prawodasastro & Benjamin 1979	
						13.8	109.8	12.2	428.9	Prawodasastro & Benjamin 1979	M
						13.6	111.4	12.1	431.4	Prawodasastro & Benjamin 1979	F
<i>Merodon</i>	<i>equestris (F.)</i>	6.7	94.5			7.2	248.6			Collier and Finch 1992	
<i>Musca</i>	<i>domestica L.</i>					11.9	77.3	11	177.9	Imai 1979	T
						11.7	77.6	11.2	189.5	Imai 1979	T
						12.5	66	11.4	188.4	Imai 1979	
<i>Musca</i>	<i>velutissima Walker</i>	8.8	139.2			13.3	129.7			Vogt et al. 1990	
<i>Oedemia</i>	<i>ornata (Meigen)</i>					2.6	92.1			Prugel 1988	
<i>Ophiomyia</i>	<i>centrosema (DeMejere)</i>	14.7	38.9	13.5	157.3	15.8	120.4	14.7	314.3	Talekar and Lee 1988	
<i>Oscinella</i>	<i>frut (L.)</i>	10.3	45.5	10.6	280.6	10.8	105.5	10.5	429.2	Tolley and Niemczyk 1988	
<i>Parasarcophaga</i>	<i>knabi Parker</i>							10.1	339.8	Woodcock 1975	
<i>Pegomya</i>	<i>hyosciami (Panzer)</i>			11.3	92.3					El-Ziady and Dimetry 1970	
<i>Phaenopsectra</i>	<i>flavipes Kaltenbach</i>			2.4	452.7					Mackay 1977	
<i>Polypedium</i>	<i>convictum (Walker)</i>			4.2	144					Mackay 1977	
<i>Psorophora</i>	<i>confinis Lynch Arribalzaga</i>			14.2	48.3	12.8	17.5			Gunstream and Chew 1967	
<i>Rhagoletis</i>	<i>completa Cresson</i>	8.1	52.2							Kasana and Ali-Nazee 1994	
<i>Rheotanytarsus</i>	<i>photophilus Goetigheuber</i>			4.6	87.7					Mackay 1977	
<i>Sarcophaga</i>	<i>crassipalpis Macquart</i>							10.5	180.3	Chen et al. 1987	
<i>Simulium</i>	<i>kawamurae Matsumura</i>					1.7	85.1			Babe 1992	
<i>Simulium</i>	<i>nigrilarsis Coquillett</i>					2.1	86.3			Begmann 1992	
<i>Simulium</i>	<i>noelleni Fiedrichs</i>					4.8	17.1			Stohr nad Ruhn 1992	
<i>Synorthocladus</i>	<i>semovirens (Kaltenbach)</i>			3.5	100					Mackay 1977	
<i>Tabanus</i>	<i>taeniola P. de Beauvois</i>	12.9	64.7			12.7	153.8			Halez et al. 1970	
<i>Tipula</i>	<i>subnodicornis Zetterstedt</i>	3.4	153.2			2.9	128			Butterfield 1976	
<i>Toxophrynites</i>	<i>nitilus septentrionalis (Dyer & Kna)</i>	8.8	39.6	9.9	184	8.3	87	9.5	318.2	Trimble and Smith 1978	
		9.9	36.4	9.5	185.1	9.7	70.1	9.9	284.6	Trimble and Smith 1978	
<i>Winthemia</i>	<i>fumiferanae Toham</i>	8.6	22.4	5.5	105.5					Hebert and Cloutier 1990	
				5.2	104					Hebert and Cloutier 1990	M
				5.7	107.8					Hebert and Cloutier 1990	F
Ephemeroptera											
<i>Coloburiscoides</i>	<i>sp.</i>	5.8	249.3							Brittain and Campbell 1991	
<i>Ecdyonurus</i>	<i>dispar (Curtis)</i>	4.3	252.8							Humpesch 1980	
<i>Ecdyonurus</i>	<i>picteti Meyer-Dur</i>	1.9	345.7							Humpesch 1982	
<i>Ecdyonurus</i>	<i>venosus (F.)</i>	0.9	393.3							Humpesch 1982	
<i>Rhythrogena</i>	<i>hybrida Eaton</i>	4	361.4							Humpesch 1982	
<i>Tortopus</i>	<i>incertus</i>	4.8	800.4							Tsui and Peters 1974	
Heteroptera											
<i>Acanthomyia</i>	<i>tomentosicollis Stal</i>	15.3	63.9	12.8	215.2			13.6	276.7	Egwatu & Ajibola Taylor 1977	
<i>Acrosternum</i>	<i>hilare (Say)</i>	12.4	113.1	13.4	429.9			13.3	541.4	Simmons and Yeargan 1988	
<i>Adelphocoris</i>	<i>lineolatus (Goeze)</i>			11.1	275.6					Kolobova 1953	
<i>Anasa</i>	<i>insulis DeGeer</i>	14.6	104.8	16	263.1			15.7	365.3	Fargo and Bonjour 1988	
		15.3	104.8	14	424.8			14.3	527.6	Felding and Ruesnik 1988	
<i>Arma</i>	<i>custos (F.)</i>	12.6	94.5							Saulich and Volkovich 1994	
		11.7	111.2							Saulich and Volkovich 1994	
<i>Bipronotus</i>	<i>bibax (Bredin)</i>	15.5	50	14.9	361.3			15	410.7	James 1990	
<i>Calocoris</i>	<i>nonvegicus (Gmelin)</i>							6.4	266.1	Purcell and Welter 1990	
<i>Cavignalis</i>	<i>tomentosicollis Stal</i>			8.5	328.5					Jucka and Inang 1992	T
				8.4	335.8					Jucka and Inang 1992	T
<i>Cermatulus</i>	<i>nasalis (Westwood)</i>	13.1	55.8	10.9	298.1			11.9	338	Awan 1986	
<i>Chlorochroa</i>	<i>uhleri Stal</i>	9.2	92.3							Jubb and Watson 1971	
<i>Corythucha</i>	<i>ciliata (Say)</i>	11.8	81.9							Santini and Grovetti 1985	
<i>Corythucha</i>	<i>cydoniae (Fitch)</i>	11.2	178.1	11.3	217.5			11.2	386.6	Neal and Douglass 1990	
				11.3	217.5			11.2	386.6	Neal and Douglass 1990	
				11.1	223.9			11.1	403.1	Neal and Douglass 1990	M
<i>Creonteades</i>	<i>ditus (Stal)</i>	13.3	99	13.5	167			13.4	263.1	Foley and Pyke 1985	F
<i>Diplonychus</i>	<i>japonicus Vulleffroy</i>			14.3	294.1					Okada and Nakasugi 1993	
<i>Diplonychus</i>	<i>major Esaki</i>			11	454.1					Okada and Nakasugi 1993	

Genus	Species	Egg		Larva		Pupa		Total		Reference
		LDT	SET	LDT	SET	LDT	SET	LDT	SET	
Dolycoris	baccarum (L.)							10.8	505.8	Conrad-Larsen & Somme 1973
Geocoris	punctipes (Say)	14.4	113.1							Cave and Gaylor 1988 H
		15.1	107.7							Cave and Gaylor 1988 H
		15	108.3							Cave and Gaylor 1988 H
		14.9	110							Cave and Gaylor 1988 H
		15.1	106.7							Cave and Gaylor 1988 H
		15	106.1							Cave and Gaylor 1988 H
		12.3	125.7	13.6	349			13.4	471.6	Champlain and Sholdt 1967
Gerris	buenoi Kirikady							6.4	535.3	Spence et al. 1980
Gerris	comatus Drake & Hottes							8.9	466.1	Spence et al. 1980
Gerris	paludum insularis (Motschulsky)	13	92.9	12.6	395.6			12.6	489.4	Park 1988
Gerris	pingraensis Drake & Hottes							7.7	459.1	Spence et al. 1980
Lygus	desertus Knight	11.3	119.4							Butler 1970
				12.2	185.6			11.9	304.7	Butler 1970 M
				11.9	304.7			12.2	298.2	Butler 1970 F
Lygus	hesperus Knight	8.3	142.8	6.8	309.7			8.2	422.2	Champlain and Butler 1967
Lygus	immaculatus (P. de Beauvois)	13.1	92.7	11.7	282.7			12.7	334.4	Ridgway and Gynasco 1960
Microvelia	douglasi Scott	16.5	47.8	14.5	151.7			15.2	198.6	Muray and Nakasugi 1988
Microvelia	horvathi Lundblad	15	53.3	14.8	144.3			14.5	207.7	Muray and Nakasugi 1988
Microvelia	kyushuensis Esaki & Miyamoto	16.4	56.6	15.5	167.3			15.8	222.5	Muray and Nakasugi 1988
Nabis	zinnicoferus (Carayon)	12	114.3	12.2	241.1			12.3	350.4	Braman et al. 1984
		13.2	103.1	12.6	233.4			12.8	334	Braman and Yeargan 1988
Nabis	roseipennis (Reuter)	10.9	165.1	10.3	338.8			10.7	494.6	Braman et al. 1984
		12.2	149.2	10.4	335.6			11.2	474	Braman and Yeargan 1988
Nabis	rufusculus (Reuter)	13.3	131	10.8	356.6			11.6	481.7	Braman and Yeargan 1988
Nezara	viridula L.			12.1	479.5			11.5	582.6	Als and Ewness 1977 P
				9.8	494			9.2	601.2	Als and Ewness 1977 P
Nysius	vinitor Bergroth	13.5	75.4							Kehat and Wyndham 1972
				15	197.2			15.7	264.5	Kehat and Wyndham 1972 M
				15.8	203.9			15.5	271.7	Kehat and Wyndham 1972 F
Oechalia	schellenbergi (Guérin-Ménéville)	12	125	14.2	285.8			14.1	396.2	Awan 1988
Oncopeltus	fasciatus (Dallas)							20.3	168.5	Baldwin and Dingle 1986
								17.9	255.7	Baldwin and Dingle 1986
Orius	majusculus (Reuter)	4.9	91.2							Alauzet et al. 1992
				9	198			9.4	251.2	Alauzet et al. 1992 T
				8.5	297.8			8.8	397.4	Alauzet et al. 1992 T
				8.1	276.9			8.5	341.5	Alauzet et al. 1992 T
Orius	sauteri (Poppus)	11	59.1	11.8	151.8			11.6	210.5	Nakala 1995
Oxycaenus	hyalinipennis Costa	6.5	159.5							Dimetry 1972
		7.3	120.1							Dimetry 1972
		2.1	153.5							Dimetry 1972
		5.7	131.1							Dimetry 1972
		4.2	139.2	15.1	258			13.7	364.8	Dimetry 1972
Pezodorus	hybneri							14.1	282.1	Higuchi 1994
Podisus	acutissimus Stål	12	74.4	12	242.6			12	316.8	Stoner et al. 1974
Podisus	maculiventris (Say)	10.4	80	11.4	282.2			11.2	361.9	DeClercq and Degheele 1992
Podisus	sagitta (F.)	13.8	57.7	13.2	238.6			13.3	296	DeClercq and Degheele 1992
Prosthesancus	plagiipennis Walker	11.5	231.5	15.2	727.8			14.8	954.9	James 1982
Pyrhocoris	apterus L.			12.4	415.2					Numata et al. 1993
Rhinacola	forticornis (Reuter)	13.8	99.8							Butler 1970
				12.8	172					Butler 1970 M
				11	186.2					Butler 1970 F
Spanagoricus	albifasciatus (Reuter)			15	145.3					Butler 1970 M
				14.8	149.4					Butler 1970 F
Stephanitis	pyroides (Scott)	12.7	176.8	12.8	177.7			12.8	354.4	Neal and Douglass 1988
				12.6	183			12.7	389.8	Neal and Douglass 1988 M
				13	174.5			12.8	351.2	Neal and Douglass 1988 F
Stephanitis	takoyai (Drake and Mesa)	6.9	226.6							Tiso et al. 1991-2
										Tiso et al. 1991-2 M
										Tiso et al. 1991-2 F
		6.9	226.6	9.7	205.2			6.2	433.6	Tsukada 1994 T,M
		6.9	226.6	9.6	206.6			8.5	427.6	Tsukada 1994 T,F
		8.8	233.5	10.2	163			9.1	379	Tsukada 1994 T,M
		6.8	233.5	10.5	156.9			9.3	371	Tsukada 1994 T,F
Trioxys	ampliata (Hennrich Schaeffer)	9.7	128.4							Egusagie 1972
Homoptera										
Austrosca	widginsae (Paoli)	15.2	90.6	12	189.3			14	239.4	Page 1983
Bemisia	tabaci (Gennadius)	10.4	118.1	13.5	266.3			11.2	422.4	Arx et al. 1983
		12.4	93.7					10.2	327.3	Butler et al. 1983
		13.9	53.4	10.8	182.5			11.9	231.1	Powell and Ballows 1992a T
		15.6	54.8	13.7	162.9			14.4	214.8	Powell and Ballows 1992a T
Chonaspis	pinifoliae (Fitch)	10.6	151							Burden and Hart 1989
Cicadulina	mbila (Naudé)									Rensburg 1982
		11.7	117.3					12.9	343.6	Rensburg 1982 M
								13.7	325.4	Rensburg 1982 F
		14.3	110.7					15.3	286.4	Rose 1973 M

Genus	Species	Egg		Larva		Pupa		Total		Reference	
		LDI	SET	LDI	SET	LDI	SET	LDI	SET		
Cicadulina	mbila (Naude)							14,6	322,3	Rose 1973	F
Cicadulina	parazae Ghauri	15,6	100,3					15,1	303,6	Rose 1973	M
Cicadulina	storeyi China	15,4	100,8					18,2	284,4	Rose 1973	F
Cicadulina								15,5	273,7	Rose 1973	M
Cicadulina								15,5	286,1	Rose 1973	F
Circulifer	opacipennis (Lethierry)	18,1	114,6	16	162			15,1	362,2	Bindra and Kaur 1970	
Empoasca	labae (Harris)	14,2	111,8	15,7	197,1			15,2	307,6	Sengonca et al 1991	
Empoasca		9,2	141,9	8,8	210,6			8,9	352,2	Sher and Shields 1991	M
Empoasca				7,7	258,6			8,3	386,1	Sher and Shields 1991	F
Graminella	nigrifrons (Forbes)	14,1	98,8	13,7	212,9			13,8	311	Sedlacek et al 1990	M
Graminella		14,2	98,3	12,8	254,4			13,2	349,3	Sedlacek et al 1990	F
Haplaxius	crudus VanDuzee	16,2	151,4	11,3	776,7			12,8	904,3	Tsai and Kirsch 1978	
Leodelphax	stratellus (Fallén)	12,5	99,7	12,6	165,3			13,3	247,7	Noda 1989	M
Leodelphax				12,4	185,4			12,5	277,6	Noda 1989	F
Leodelphax		11,8	113,8	11,6	184,7			12,2	283,4	Noda 1989	M
Leodelphax				11,6	192,2			12,1	295,3	Noda 1989	F
Leodelphax		12	107,7	12	168,9			13,3	243,4	Noda 1989	M
Leodelphax				11,7	183,7			13	258,8	Noda 1989	F
Lepidosaphes	becki Newman			11,5	426,7					Hafez and Salama 1969a	M
Lepidosaphes				13,4	265,7					Hafez and Salama 1969a	F
Nephotettix	cincticeps Uhler	14,1	97,3	15,9	162,9					Valle et al 1986	
Nephotettix	malayanus Ishihara & Kawase	14,1	97,5	14,6	231,5					Valle et al 1986	
Nephotettix	nigropictus Stål	13,2	119,8	15	194,2					Valle et al 1986	
Nephotettix	virescens Distant	14,4	98,4	15,6	184,5					Valle et al 1986	
Nilaparvata	lugens (Stål)	13	105,7							Noda 1989	
Nilaparvata				11,8	179,3					Noda 1989	M
Nilaparvata				11,7	183,1					Noda 1989	F
Phenacoccus	herreni Cox & Williams	14,7	70,5							Herrera et al 1989	
Phenacoccus				16,1	127,7			15,8	195,8	Herrera et al 1989	M
Phenacoccus				15,6	130,2			15,4	207,6	Herrera et al 1989	F
Phenacoccus	manihoti Mal-Ferr	13,8	100,9	19	104,4			17,7	192,3	Khegsum and Ekwa 1983	
Pseudaulacaspis	pentagona (Targion-Tozzetti)	9,9	47,7							Bail 1980	
Pseudaulacaspis				4,2	419,8			5,9	447,3	Bail 1980	M
Pseudaulacaspis				2,3	515,8			4,6	528,5	Bail 1980	F
Pyrausta	perpusilla Walker	14,4	109,2							Gupta and Ahmad 1981	
Saccharicoccus	sacchari Cockrell			13,5	223,7					Hafez and Salama 1969b	DM
Saccharicoccus				13,7	251,9					Hafez and Salama 1969b	DM
Saccharicoccus				13,9	228,4					Hafez and Salama 1969b	F
Saissetia	oleae (Olivier)	11,8	170							Conti 1987	
Sogatella	furcifera (Horváth)			11,7	158,5					Noda 1989	M
Sogatella				11,8	167,3					Noda 1989	F
Spissatiellus	festinus (Say)			10,2	407,8					Spurgeon and Mack 1990	
Typhlocyba	froggatti Baker	9,9	226	8,8	262,6			9,4	486,4	Toulon and Penman 1987	
Hymenoptera											
Acerophagus	coccoides Smith							14,7	192,3	Herrera et al 1989	
Anagyrus	pseudococcoides (Girault)							13,6	172	Tingle and Copland 1988	
Anagyrus	flavipes (Foerster)	9,6	9,1	6,8	78	8	72,4	8	155,5	Anderson and Paschke 1989	
Anastatus	semiflavus Gahan							10,3	625,4	Mendel et al 1989	
Anisopteromimus	calandriae (Howard)							16,5	133,5	Smith 1992	M
Anisopteromimus								16,8	137,5	Smith 1992	F
Anisopteromimus								13,9	233,3	Ueda and Nagasawa 1949	F
Anisopteromimus								10	255,7	Al-Mutairi et al 1986	
Apantheles	sp. group ulior			9,8	254,8	10	115,5			Lysyk and Nealis 1988	M
Apantheles	furnerianae (Viereck)			9,2	336,9	12,9	81,7			Lysyk and Nealis 1988	F
Apantheles						10,3	99,9			Nealis and Fraser 1988	
Apantheles	acutellans Muesebeck							14,3	179,7	Cardona and Oatman 1975	
Apantheles	subaditus Blanchard	12,7	15,5	11,9	124,9	10,2	102,6	11,4	242	Cardona and Oatman 1975	
Aphelinus	abdominatus Oatman							8,3	249,9	Bassolei 1988	
Aphelinus	asyches Walker							7,5	238,1	Bernal and Gonzalez 1993	
Aphelinus								6,8	267,7	Bernal and Gonzalez 1993	
Aphelinus	mail (Haliday)					9,3	136,8			Trimble et al 1990	
Aphelinus	sp. near varipes (Foerster)							9,2	233,2	Lajeunesse & Johnson 1992	T
Aphelinus								9,2	233,6	Lajeunesse & Johnson 1992	T
Aphelinus								8,9	241,4	Lajeunesse & Johnson 1992	T
Aphidius	colemanti Viereck							4	201,6	Steenis 1993	M
Aphidius								1,5	235,2	Steenis 1993	F
Aphidius	maincanee Haliday							4,6	273	Miller and Gerth 1994	
Aphidius								1,4	317,3	Bernal and Gonzalez 1993	
Aphidius	sonchi Marshall							6,6	177,6	Lu and Hughes 1984	
Aphidius								7	167,8	Lu and Hughes 1984	
Aphytis	chrysomphali (Mercet)							12,4	194,4	Abdelrahman 1974	F
Aphytis								4,8	264,6	Kfir and Luck 1984	
Aphytis	lingnanensis Compere							10	222,4	Kfir and Luck 1984	
Aphytis	melinus DeBach							13,3	187,8	Abdelrahman 1974	M
Aphytis								13,4	187,7	Abdelrahman 1974	F
Aphytis								7,3	285,1	Kfir and Luck 1984	

Genus	Species	Egg		Larva		Pupa		Total		Reference	
		LDT	SET	LDT	SET	LDT	SET	LDT	SET		
Bracon	instabilis Marshal							10,7	176,8	Abbas and Abou-Zeid 1963	T
								11	191	Abbas and Abou-Zeid 1963	T
Bracon	melitor Say	11,8	11,9					11	205,5	Barfield et al 1977	M
								9,6	264,4	Barfield et al 1977	F
Brachymera	laevis (Walker)					13,3	73,6	12,8	176	Mao and Kunimi 1994	M
						12,8	80,3	12,3	202,4	Mao and Kunimi 1994	F
Cardiochiles	nigroceps Viereck							13,5	364,4	Butler et al 1963	
Catolaccus	grandis (Burks)							10,9	203,5	Morales-Ramos & Cate 1993	M
								11,5	229,9	Morales-Ramos & Cate 1993	F
Cephalonomia	stephanodens Batem	12,2	28,6							Infante et al 1992	
				13,4	59,1	14,1	168	13,6	257,1	Infante et al 1992	
				13,9	102,9	13,6	118,8	13,6	247,5	Infante et al 1992	
Chelonus	inartus (L.)							16	261,8	Rechav and Onon 1975	T
								16,1	287,2	Rechav and Onon 1975	T
Coccobius	fulvus (Compère & Annecke)							11,5	355,6	Ogata 1987	M
								11,5	374,8	Ogata 1987	F
Copidosoma	koehleri Blanchard							9,8	563,4	Horne and Horne 1991	
Cotesia	flavipes (Cameron)							3,4	415,8	Sathe and Nikam 1984	
Cotesia	melanoscela (Ratzeburg)					10,3	74,5			Gould and Elkinton 1990	M
						10	83,8			Gould and Elkinton 1990	F
Cotesia	urbae Austin and Allen					9,5	89			Allen and Keller 1981	
						9,3	89			Allen and Keller 1981	M
						9,7	89			Allen and Keller 1981	F
Dendrosoter	sulcatus Muesebeck							16,5	114,2	Jones and Stephen 1994	M
								16,5	131,4	Jones and Stephen 1994	F
Dacnabellia	rapae (Mittelsch)							3	311,2	Bernal and Gonzalez 1995	
								3,4	258,6	Bernal and Gonzalez 1995	
Diglyphus	isaea (Walker)					8	87,1	9	167,3	Minkenber 1989	T,M
						7,6	96,4	8,8	178,1	Minkenber 1989	T,F
						5,7	96,3	7,9	165,7	Minkenber 1989	T,M
						7,1	93	8,8	154,2	Minkenber 1989	T,F
								11	183,1	Cheah 1987	M
								11,1	181,7	Cheah 1987	F
Dinotiscus	dendroctoni (Ashmead)							11,5	244,1	Jones and Stephen 1994	M
								11,3	267,8	Jones and Stephen 1994	F
Diprion	pallipes (Fallén)			8,4	286,4					Mallach 1974	
				7,8	278					Mallach 1974	
				6,7	303,5					Mallach 1974	
				11,1	255,8					Mallach 1974	
Diprion	pini (L.)	5,3	222,5							Eichhorn 1977	
Ooichogenidea	eucalypti Austin and Allen					10,7	86			Allen and Keller 1981	
Edosium	puttleri Grissell							10	241,6	Lashomb et al 1967	
Encarsia	permiosus (Tower)							8	399,3	McClain et al 1990	M
								5,2	520,1	McClain et al 1990	F
Encarsia	vinicolor Foerster							9,7	368,5	Avila and Copland 1988	M
				8,6	111,5			9	271,5	Avila and Copland 1988	F
Epidinocarsis	diversicornis (Howard)							11,5	268,3	Herrera et al 1989	
Eretmocerus	sp							9,4	373,1	Powell and Bellows 1992b	T,M
								10,6	337,5	Powell and Bellows 1992b	T,F
								13,2	240,2	Powell and Bellows 1992b	T,M
								12,7	265,4	Powell and Bellows 1992b	T,F
								8,9	377,4	Powell and Bellows 1992b	T,F
								12,4	267,9	Powell and Bellows 1992b	T,F
Eurytoma	amygdali Enderlin	11,1	69,7							Plaut 1972	
						9,8	189,2			Plaut 1972	F
Glypta	fumiferanae Viereck			8,9	383,8	7,2	183,1			Lysyk and Neatis 1988	M
				9,1	381,8	8,3	150,1			Lysyk and Neatis 1988	F
Gonolocerus	cinctipalpis Sathad							11	169,6	Miura 1990b	M
								11,4	166,2	Miura 1990b	F
Graminella	nigrifrons (Forbes)							13,7	337,6	Larsen et al 1990	
Leptomastix	abnormis (Girault)							11,1	343,8	Tingle and Copland 1988	
Leptomastix	dactylopi Howard							13,7	190,3	Tingle and Copland 1988	
Maretta	cameras Howard							12,7	259	Uematsu 1974	
Megachile	pacificus Panzer			15,1	169,4	18,4	89,1			Tasen and Masure 1978	M
				15,8	158,1	18,1	108,7			Tasen and Masure 1978	F
Megachile	rotundata (F.)	14,3	32,3	13,1	163,5					Whitfield and Richards 1992	
Neodiprion	fulvipes (Cresson)	5,8	443							Tisdale and Wagner 1990	D,M
		7,5	369							Tisdale and Wagner 1990	D,M
Oenocryptus	nezarai Ishii							10,9	199,1	Numata 1993	P
								12	182,6	Numata 1993	P
Orthotomicus	erosus (Wollaston)	12,1	62,3			15,7	30,2			Mendel and Halperin 1982	
Paracentrobia	andrei (Ishii)							14,1	183,4	Miura 1990a	
Perilissus	stypicus Loeb					1,6	327,5	4,7	515,6	Butler and Wardacker 1974	
						5,3	260,2	5	497,8	Butler and Wardacker 1974	
Solenopsis	invicta	16,2	91,5	18,3	175,1	17,6	101,8	18,3	347,2	Porter 1968	
Spathius	pallidus Ashmead							13,1	191,9	Jones and Stephen 1994	M

Genus	Species	Egg		Larva		Pupa		Total		Reference	
		LDT	SET	LDT	SET	LDT	SET	LDT	SET		
<i>Spathius</i>	<i>pallidus</i> Ashmead							13,1	206,1	Jones and Stephen 1994	F
<i>Telenomus</i>	<i>chrysopa</i> Ashmead							11,5	137,9	Ruberson et al. 1995	
								12,1	126,4	Ruberson et al. 1995	
<i>Telenomus</i>	<i>lobatus</i> Johnson and Bin							11,9	161,3	Ruberson et al. 1995	
<i>Telenomus</i>	<i>podisi</i> Gorch and Coker							14,7	170	Cave and Gaylor 1988	H,M
								14,5	177,5	Cave and Gaylor 1988	H,F
								14,5	160,4	Cave and Gaylor 1988	H,M
								14,4	170,9	Cave and Gaylor 1988	H,F
								14,6	151,6	Cave and Gaylor 1988	H,M
								14,6	158,8	Cave and Gaylor 1988	H,F
								14,3	158,1	Cave and Gaylor 1988	H,M
								14,3	166,3	Cave and Gaylor 1988	H,F
								14,5	148,8	Cave and Gaylor 1988	H,M
								14,5	161,3	Cave and Gaylor 1988	H,F
								14,2	153,9	Cave and Gaylor 1988	H,M
								14,4	180	Cave and Gaylor 1988	H,F
<i>Telenomus</i>	<i>utahensis</i> Ashmead							14,7	109,9	Jubb and Watson 1971	T
								14,6	112,1	Jubb and Watson 1971	T
								15,1	108,7	Jubb and Watson 1971	T
								14	122,9	Jubb and Watson 1971	T
								15,8	109	Jubb and Watson 1971	T
								14,5	105,8	Jubb and Watson 1971	T
<i>Trichogramma</i>	<i>chilonis</i> Ishii							8,8	150,7	Mura and Kobayashi 1993	M
								8,5	155	Mura and Kobayashi 1993	F
<i>Trichogramma</i>	<i>pretiosum</i> Riley	13,2	15,7	12,2	62,2	13,4	49,2	13	124,7	Cahn et al. 1984	
<i>Trichopria</i>	<i>alinhomelinae</i> Muesebeck							10,5	340,4	O'Neill 1973	
<i>Trichopria</i>	<i>poppi</i> (Muesebeck)							8,2	340,9	O'Neill 1973	
<i>Trissolcus</i>	<i>basalis</i> (Wollaston)							12,9	177,8	Powell et al. 1981	
<i>Trissolcus</i>	<i>benoni</i> (Dodd)							12,5	153,2	James and Warren 1991	
<i>Urolepis</i>	<i>rufipes</i> (Ashmead)							16,2	88,5	Matthews and Petersen 1989	D,M
								15,8	101,5	Matthews and Petersen 1989	O,F
								14,5	145,4	Matthews and Petersen 1989	D,M
								13,8	168,7	Matthews and Petersen 1989	O,F
								16	108	Smith and Rutz 1986	M
								15,9	117,8	Smith and Rutz 1986	F
Lepidoptera											
<i>Adoxophyes</i>	<i>orana</i> Fischer von Roslerstamm			8,7	319					Fluckiger and Benz 1982	
				8,6	316,5	11,1	80,4			Fluckiger and Benz 1982	
				9,5	282,5					Fluckiger and Benz 1982	
				10,2	236,8					Fluckiger and Benz 1982	
<i>Agrotis</i>	<i>upsilon</i> (Hufnagel)	3,9	80			6,8	241,7			Fahmy et al. 1973	
		12	52			10,6	181,5			Fahmy et al. 1973	H
		13,1	43,8	10,8	720,5	11,2	176,2	11,1	937,9	Fahmy et al. 1973	H
				8,5	601,4	11,7	160	9	839	Fahmy et al. 1973	H
		10,2	73,7							Harns et al. 1962	
		13,6	35,2	11	341,1	11,8	199,4	11,6	571,1	Luckmann et al. 1976	
								5,6	640,8	Nasr and Moawad 1972	H
								6,7	589,3	Nasr and Moawad 1972	H
								6,1	593,3	Nasr and Moawad 1972	H
								2,4	820,5	Nasr and Moawad 1972	H
								8,1	531,2	Nasr and Moawad 1972	H
								3,4	705,5	Nasr and Moawad 1972	H
								5,4	668,2	Nasr and Moawad 1972	H
<i>Amyeloris</i>	<i>transitella</i> (Walker)	13,9	50,4			12,3	133,8			Sanderson et al. 1989	
<i>Ancyris</i>	<i>comptana</i> (Froelich)	10,5	76,5	10,3	137,5	11	99,5	10,6	411,8	Gabriel and Obrycki 1990	
								10,7	391,3	Gabriel and Obrycki 1990	M
								10,5	415,4	Gabriel and Obrycki 1990	F
						11,6	82,1			Obrycki et al. 1990	
<i>Anticarsia</i>	<i>gemmatilis</i> (Hübner)			16,4	154	15,5	112			Leppia et al. 1977	
<i>Aproaerema</i>	<i>modicella</i> (Deventer)	13,3	51,3	15,2	181,6	15,1	74,5	15,2	275,4	Shanower et al. 1993	
<i>Argyrogramma</i>	<i>albolineata</i> (Biemer & Grey)							12,2	372,6	Uematsu 1980	
<i>Argyrotaenia</i>	<i>puicheliana</i> (Howard)	8,4	125,8	8,6	291,7	8,1	125,4	8,5	532,3	Tsio et al. 1991-2	
<i>Argyrotaenia</i>	<i>velutinana</i> (Walker)	7,7	126,7	7,4	410,7	9,9	123,5	8,1	649	Hawthorne et al. 1988	
				6,3	471,4	10,1	122	8	687,1	Hawthorne et al. 1988	M
<i>Altacus</i>	<i>noni</i> (Boisduval)	11,9	154							Gomaa 1973	H
		11,8	128,9							Gomaa 1973	H
		6,2	171,8							Gomaa 1973	H
		10,3	142,9	2,4	659,9	9,6	253,4	7	1005,6	Gomaa 1973	H
						10,4	248,7			Gomaa 1973	H,M
						9,1	281,7			Gomaa 1973	H,F
						10,9	231,6			Gomaa 1973	H,M
						10,3	262,2			Gomaa 1973	H,F
						9,9	252,8			Gomaa 1973	H,M
						8,4	284,4			Gomaa 1973	H,F
						9,1	258,5			Gomaa 1973	H,M

Genus	Species	Egg		Larva		Pupa		Total		Reference	
		LD	SET	LD	SET	LD	SET	LD	SET		
Alisus	nicini (Borsduval)					8.5	270			Gomez 1973	H,F
Autographa	bioba (Staphens)			11.8	211.8	12.2	121.5			Beach and Todd 1986	M
				10.8	231.2	12.3	116.5			Beach and Todd 1986	F
Autographa	gamma (L.)			7.7	281.8	9.2	133.4			Hill and Gatehouse 1992	M
				7.6	281.3	9.3	126.2			Hill and Gatehouse 1992	F
Cacoecomorpha	pronubana (Hubner)	10.9	121.5	8.3	392.8	5.2	193.2	8.8	685.2	Quaglia 1983b	
Chilo	auriculus Dudgeon	12.9	78.8	15.7	473.5	14.1	90.6	15.4	633.2	Mitra and Verma 1981	H
		13.1	77	15.9	461.8	12.8	104.5	15.5	626.8	Mitra and Verma 1981	H
		12.4	82.9	15.5	473.3	13.8	90	15.2	636.2	Mitra and Verma 1981	H
Choristoneura	pinus pinus Freeman					13.2	57.4			Lysyk and Nealis 1988	M
						10.5	104.9			Lysyk and Nealis 1988	F
Choristoneura	roaeseana (Harris)	10	111.9	10.8	405.4	9.4	117.4			Gangavalli and Al-Nazee 1985	
Chrysodeixis	chalcites Esper			13	156	15.2	86			Potlout and Bues 1974	
Cnaphalocrois	medialis Guenee	12.5	56.8	12.2	203.8	14.8	78.7	13.2	327	Wada and Kobayashi 1980	
Cochylis	hospes Walsingham	9.6	74.6	8.2	483.4	9.9	177	8.8	737.6	Barker and Enz 1994	
Crocosema	plebejana (Zeller)	11.6	47.4	11.1	211.8	10.7	120.8			Hamilton and Zalucki 1991	
								11.2	369.1	Hamilton and Zalucki 1991	M
								11	391.4	Hamilton and Zalucki 1991	F
Cydia	pomonella (L.)	12.2	73	12.3	216.5	13.7	163.6	12.9	451.8	Picardi et al. 1991	
		10.1	83.4	3.9	498.9	5.3	207.8	4.8	814.7	Buttunini et al. 1992	
Danaus	chrysippus L.	11.5	53.4			12.6	117.2			Zalucki 1982	
Dargida	procincta (Grote)			7	410.3	9.4	206.1			Kamm 1991	
Diatraea	grandiosella Dyar	8.1	122.3	10.6	495.3			9.8	737.7	Whitworth and Poston 1979	
Diatraea	lineolata (Walker)	12.5	78.9							Rodriguez-del-Bosque et al. 1989	
				10.8	472.2	12.4	151.3	11.3	701.9	Rodriguez-del-Bosque et al. 1989	M
				8.7	559.8	10.7	172.5	9.8	802.3	Rodriguez-del-Bosque et al. 1989	F
Doryctes	amalella (Hulst)	12.2	79.4							Hamula et al. 1984	
Ectomyioides	ceratoniae (Zeller)	12.5	52.5	10.1	330.8	13.5	100	10.8	441.6	Cox 1976	
Ephestia	calidella (Guenee)	10.8	77.3	11	318.8	11.6	139.5	9.8	582.3	Cox 1974	H
				22.1	223.5	18.9	92.3			Prevett 1966	
		22.1	17.8	21.5	391.6	19.3	60.7	21.4	462.5	Omar et al. 1973	
Ephestia	cautelata (Walker)	10.4	75.7			11	168.7	10.5	624.8	Bell 1975	
		10.2	79			11.1	165.7	10.9	607.8	Bell 1975	
Ephestia	elutella (Hubner)	10	80			11.8	135.5	10.5	513	Bell 1975	
		12.7	51.4			12.8	121.4	12.1	458.8	Bell 1975	
Ephestia	figulella Gregson	11.3	73.1							Cox 1974	H
		11.1	72.3	10	713.9	12.5	129.8	10.4	855	Cox 1974	
Ephestia	kuehnelia Zeller	11.8	62.6			14.7	95.6	12.4	478.8	Bell 1975	H
		11.3	64.3			14.8	90.6	12.2	461.7	Bell 1975	
		10.1	72	9.3	1064	10.7	160.8	9.4	1333.7	Jacob and Cox 1977	H
		9.5	76	8.3	1257.4	10.5	159.6	7.3	1479.7	Jacob and Cox 1977	H
Epichlorodes	acerbella (Walker)	11.1	115.9	8.1	393.1	4.5	197.6	8.7	555.8	Quaglia 1983a	
Epiphyas	posvittana (Walker)	7.6	112.9							Danthanarayana 1975	
				7.1	333.6	7.5	128.2	7.5	581.2	Danthanarayana 1975	T
				8	310.4	7.1	132.6	7.9	543.8	Danthanarayana 1975	T
				6.7	398.8	6.7	135.6	7	634.2	Danthanarayana 1975	T
				7.1	351.2	8	128.8	7.6	578	Danthanarayana 1975	T
Eudocima	salamina (Cramer)	11	53	11.9	280.2	12.8	206	12.3	533.3	Sands et al. 1991	
Euproctis	chrysorrhoea (L.)	11.7	91			7.9	213			Pantylukhov 1962	
		11.5	97.8			7.5	225.2			Pantylukhov 1962	
Galleria	melonella (L.)					9.4	186.7			Stark 1978	
Grapholitha	funebrana Treitschke	10.4	73			10.3	154.2			Charadot et al. 1979	
Grapholitha	moesta (Busck)	3.4	85.5			1.3	323.7	5.5	791.4	Chaudhry 1955	H
		8.4	88.2	7.3	405.8	3.8	301.2	6.2	764.8	Chaudhry 1955	H
		8	74.8			4.8	329.7	6.3	806.4	Chaudhry 1955	H
Harmenia	brillians Barnes&MacDunnough	9.6	134.1	8.3	435.8					Rottsch et al. 1990	
Heliothis	amigera (Hubner)					14.7	156.3			Foley 1981	
		12.2	40.3							Kay 1981	
		5.4	75	10.2	298.4	13.7	160.9	12	502.7	Sharma and Chaudhury 1988	
				11.8	235.7	14.3	152.4			Twine 1978	
		9.4	53.6	9	267.1					Wu et al. 1980	
						13.5	165.5	11.9	454.7	Wu et al. 1980	M
						13.4	152.8	11.6	448.5	Wu et al. 1980	F
				8.8	254.2	16.2	122.2			Potlout and Bues 1974	
Heliothis	zea (Boddie)	12.3	41.8							Luckmann 1963	
				12.5	187.5					Wiseman and Isenhour 1989	T
				9.4	295.6					Wiseman and Isenhour 1989	T
				7	468					Wiseman and Isenhour 1989	T
				8.9	498.2					Wiseman and Isenhour 1989	T
				12.5	187.5					Wiseman and Isenhour 1989	T
				12	208					Wiseman and Isenhour 1989	T
				12.7	198.4					Wiseman and Isenhour 1989	T
				9.4	295.8					Wiseman and Isenhour 1989	T
Hemileuca	olivea Cockerell	12.5	317							Mendel et al. 1989	
Heterocampa	guttivitta (Walker)	10.4	79.5	12.1	472.3					Martini and Allen 1987	
				11.7	408.8					Martini and Allen 1987	

Genus	Species	Egg		Larva		Pupa		Total		Reference	
		LD	SE	LD	SE	LD	SE	LD	SE		
<i>Homocidula</i>	<i>anisocentra</i> (Meyrick)	11.7	67.4	11.8	206.3	14.6	105.2	13.8	346.4	Bastian and Hart 1991	
<i>Hyphantina</i>	<i>cunea</i> (Drury)	13.6	93	10.8	488	10.7	199			Nordin and O'Conna 1985	
<i>Junonia</i>	<i>villosa</i> Godart			16.1	151.9	16.9	72.3			James 1987	P
				14.9	174	15	86.8			James 1987	P
<i>Lithocolletis</i>	<i>pomonella</i> Zeller	3.6	151.9	5.7	289.3	8.1	135.8	5.4	575.3	Baumgaertner et al 1981	
<i>Lymantria</i>	<i>dispar</i> (L.)			6.1	843.5	11.3	133.5			Pantukhov 1962	
				6.1	864.6	11.4	133.8			Pantukhov 1962	
<i>Mamestra</i>	<i>brassicae</i> (L.)			11.4	212.2					Portout and Bues 1974	
<i>Mamestra</i>	<i>oleracea</i> (L.)			9.5	275.8					Portout and Bues 1974	
<i>Maruca</i>	<i>festuella</i> Geyer					13.3	46.6			Jackai and Inang 1992	T
						14.5	41.1			Jackai and Inang 1992	T
						11.3	66			Jackai and Inang 1992	T
<i>Merophyas</i>	<i>divulsana</i> (Walker)	8.9	84.5							Ailsopp et al 1983	
				8.6	250.7	7.8	113	8.5	448.3	Ailsopp et al 1983	M
				8.1	277.9	7.9	98.4	8.2	460.1	Ailsopp et al 1983	F
<i>Mycalesis</i>	<i>perseus</i> (F.)	10.4	64.1							Brady and Jones 1994	
<i>Mycalesis</i>	<i>sinus</i> (F.)	11.4	72							Brady and Jones 1994	
<i>Mycalesis</i>	<i>terminus</i> (F.)	11.1	77							Brady and Jones 1994	
<i>Mythimna</i>	<i>convecta</i> (Walker)	8.4	88	6	482	8.1	236.6	7.1	801.4	Smith 1984	
				5.8	502.9	8.1	243.7	6.9	282.7	Smith 1984	M
				6.2	461.4	8.3	228.9	7.2	775	Smith 1984	F
<i>Operophtera</i>	<i>brumata</i> (L.)			1.5	333.3					Topp and Kinslan 1991	
<i>Orthosia</i>	<i>hibisci</i> Guenee	3.7	93.1	4.1	258.5	3.5	86.4			Judd et al 1994	
<i>Ostrinia</i>	<i>nubilalis</i> (Hubner)			11.8	358.2	12.8	103.5			Cahn et al 1991	
				8.1	511.2	11	125.3			Cahn et al 1991	
				10.6	435.7	10.1	143.2			Cahn et al 1991	
				10.2	447.4	8.6	188.1			Cahn et al 1991	
		13.54	44.3	10.4	279.4	10.9	119.5	10.5	480	Matteson and Decker 1965	
		11.2	48.1							Lo 1990	
<i>Pandemis</i>	<i>ceresana</i> (Hubner)	8.6	116.4	4.4	735.7	7.7	131.9	5.8	967.4	DeBernardis & Buttner 1991-2	
<i>Panolis</i>	<i>flavimacra</i> (Clemens and Schiffermu)	1.9	133.1							Leather 1994	
<i>Papaipetia</i>	<i>nebula</i> (Guenee)	8.3	190.5	3.1	1480.8	5	406.7	4.8	2026.9	Levine 1983	
<i>Papilio</i>	<i>demoleus</i> L.					1.4	243.2			Alwal 1977	
<i>Papilio</i>	<i>glaucus</i> L.			9.9	457.7					Scriber and Lederhouse 1983	
<i>Papilio</i>	<i>glaucus australis</i> Maynard			10.4	351.4					Ritland and Scriber 1985	
<i>Papilio</i>	<i>glaucus canadensis</i> R&J			10.6	366.6					Ritland and Scriber 1985	
				9.1	420.3					Ritland and Scriber 1985	
				9	422.6					Ritland and Scriber 1985	
				11.2	383.8					Ritland and Scriber 1985	
<i>Papilio</i>	<i>glaucus glaucus</i> L.			10.3	322.3					Ritland and Scriber 1985	
				9.4	333.4					Ritland and Scriber 1985	
				13.2	321					Ritland and Scriber 1987	
				12.9	326.5					Ritland and Scriber 1988	
				12.8	331.1					Ritland and Scriber 1989	
				13	348.8					Ritland and Scriber 1990	
<i>Papilio</i>	<i>glaucus x canadensis</i>			10.2	327.6					Ritland and Scriber 1991	
				8.1	417.4					Ritland and Scriber 1992	
				8.7	400					Ritland and Scriber 1993	
				9.3	447.8					Ritland and Scriber 1994	
<i>Pararge</i>	<i>aegeria</i> (L.)							5.5	576.8	Nylin et al 1993	M
								5.4	623.6	Nylin et al 1993	F
								5.2	524.7	Nylin et al 1993	M
								8.5	469.2	Nylin et al 1993	F
								5.7	548.3	Nylin et al 1993	M
								4.8	611.5	Nylin et al 1993	F
<i>Pactinophora</i>	<i>gossypii</i> (Saunders)					13.1	487.4			Phapp and Watson 1971	
<i>Pendroma</i>	<i>saucia</i> (Hubner)	5.9	77.8	3.7	471.9	5.2	283.6	4.6	828.4	Shields 1983	
<i>Phigophora</i>	<i>meliculusa</i> L.			3.6	572.1	5.5	401.5			Bues and Portout 1980	
				4.2	678.4	6.9	351.1			Bues and Portout 1980	
<i>Phthonimaea</i>	<i>operculella</i> (Zeller)							10.4	432.4	Horne and Horne 1991	
								15.9	241.2	Cardona and Oatman 1975	
		7.5	93.3	8.2	228.2	5	203.4	7.1	521	Al-Jabiri 1984	
<i>Phyllonorycter</i>	<i>biancardella</i> (F.)	3.8	130.6	5.9	250.9	5.8	134.8	5.4	514.3	Trimble 1994	
		3.3	148.3	8.4	247.4	6.9	120	4.2	628.6	Baumgaertner et al 1981	
<i>Pieris</i>	<i>brassicae</i> L.			8.9	192.6	10.7	109.1			Breugnot 1972	
<i>Pieris</i>	<i>rapae</i> (L.)			9.4	193.6					Talchell 1981	
<i>Platypena</i>	<i>scabra</i> (F.)	10.6	66.6							Hammond et al 1979	
				6.2	401.5	10.2	148.5	8.4	595.8	Hammond et al 1979	M
				6.2	376.2	10.8	124.9	8.6	547.9	Hammond et al 1979	F
<i>Platynota</i>	<i>flavescens</i> Clemens	10	111.5	8.7	370.3	8.8	128.5	9	609.8	David et al 1989	
<i>Platynota</i>	<i>idaeusalis</i> (Walker)	9.6	105.5	7.7	410.9	7.7	142.1	8.1	655.9	David et al 1989	
				9.9	325.9	8.9	133.6			Rock 1985	M
				10	339.5	8.2	134.5			Rock 1985	F
<i>Plodia</i>	<i>interpunctella</i> (Hubner)	10.3	96.3			10.8	195.4	13.1	555.3	Bell 1975	
		10.5	91.1			10.8	188.6	11.3	616	Bell 1975	
		10.5	82.1	14.3	257.4	7.4	142.4	13	458.4	Athab 1987	

Genus	Species	Egg		Larva		Pupa		Total		Reference
		LDI	SET	LDI	SET	LDI	SET	LDI	SET	
<i>Podia</i>	<i>interpunctella</i> (Hubner)			12.7	279.4	14.9	83.7			Pirelli 1971
						14.9	93.2			Pirelli 1971
								12.2	414.5	Swatonek 1975
<i>Phlebia</i>	<i>xylosteella</i> (L.)					8.7	68.5	9.7	225.6	Umeya and Yamada 1973c M
						8.9	59.1	9.5	228.6	Umeya and Yamada 1973c F
						8.4	74.9	7.5	286	Umeya and Yamada 1973c M
						8.5	69.2	7.5	281.3	Umeya and Yamada 1973c F
<i>Pseudaletia</i>	<i>unipuncta</i> (Heworth)	8.8	46.4	9.8	145.3	10.8	56.7	9.9	246.5	Yamada and Kawasaki 1968
		11.8	57.1	11	292.1	9.2	234	10.5	578.1	Taylor and Shields 1990
<i>Quadracinarifer</i>	<i>punctatella</i> (Motschulsky)			0	460.5	0.3	358.4			Portout and Bues 1974
				5.6	425.7					Kamala and Igarashi 1995 D
				7.3	439.2					Kamala and Igarashi 1995 D
<i>Scolia</i>	<i>ipilion</i> (Hufnagel)			16.8	143.8	12.9	208			Portout and Bues 1974
<i>Scolia</i>	<i>segetum</i> (Dennis & Schiffermüller)					14.9	187.1			Portout and Bues 1974
				11	462.5	12.1	200.1			Weismann & Podmanická 71 T
				10.8	513.6	11.7	223.7			Weismann & Podmanická 71 T
				12.4	397.7	8.8	235.3			Weismann & Podmanická 71 T
				11.8	536.5	7.1	260.9			Weismann & Podmanická 71 T
				10.5	423.6	6.4	275.9			Weismann & Podmanická 71 T
				10.7	738.5	7	283.6			Weismann & Podmanická 71 T
				10.5	588.6	8.7	238.2			Weismann & Podmanická 1971
<i>Spodoptera</i>	<i>exigua</i> (Hubner)	10.7	47.5							Hogg and Gutierrez 1980
		12.8	36.3							Ali and Gaylor 1992
				12.7	130.6	13.1	97.5	12.9	261.3	Ali and Gaylor 1993 T
				13.1	128	13.7	88.1	13.4	249.2	Ali and Gaylor 1994 T
				11.4	185.9	12.9	104.4	12.3	321.4	Ali and Gaylor 1995 T
				16.1	87.8	8.4	171.4			Portout and Bues 1974
<i>Spodoptera</i>	<i>frugiperda</i> (Smith)	12.7	39.9							Ali et al 1990
				12.4	182.3	13.7	116.4			Ali et al 1990
				12.8	204.1	13.7	113.6			Ali et al 1990
				12.9	270.7	14.4	106.7			Ali et al 1990
				17.9	194.2					Izenhour et al 1985
				16.6	180.6					Izenhour et al 1985
				17	213.8					Izenhour et al 1985
				15.3	205.1					Izenhour et al 1985
				16.1	240.8					Izenhour et al 1985
						12.8	122.1			Simmons 1992
						12.6	107.1			Simmons 1992
		5	56.6							Combs and Valerio 1980
				8	331.2	8.1	148.1	8.7	533.8	Combs and Valerio 1980 T
				8.8	262.7	9.4	138.8	11.3	378.3	Combs and Valerio 1980 T
				8.5	274.4	9.5	133.6	8.6	461.7	Combs and Valerio 1980 T
				5.5	309.3	8.3	148.7	5.6	511	Combs and Valerio 1980 T
<i>Spodoptera</i>	<i>litorea</i> (Boursuval)							10.3	320.2	Bhat & Bhattacharya 1976 T,M
								10.3	310.8	Bhat & Bhattacharya 1976 T,F
								11.4	283.3	Bhat & Bhattacharya 1976 T,M
								12.2	242.5	Bhat & Bhattacharya 1976 T,F
				8.6	280			11	431.8	Nasr et al 1973
				9.7	285.6			12.6	419.9	Nasr et al 1973
				9.4	305.8			14.8	375.8	Nasr et al 1973
				16.5	119.2	14.7	137.4			Portout and Bues 1974
				11.7	236.8					Sidibe and Lauge 1977
				7.2	307.2					Blapata and Thombre 1979
<i>Spodoptera</i>	<i>litura</i> (F.)	9.8	55.3			10.4	160.1			Myashita 1971
				11.5	245.3			11	470.4	Myashita 1971 T
				12.9	260.6			12	479.9	Myashita 1971 T
<i>Trichoptusia</i>	<i>ni</i> (Hubner)	10.4	52.4	11.5	252.1	9.9	168.4	11.2	459.2	Rao et al 1989
<i>Trichoptusia</i>	<i>onchalea</i> (F.)			8	269			12.3	331.6	Toba et al 1973 F
				8.1	267			10.2	122.6	Cabbello 1968 P,M
				11.3	194.1			10.6	110.7	Cabbello 1968 P,F
				11	206.7			11.6	125.6	Cabbello 1968 P,M
								11.8	108	Cabbello 1968 P,F
<i>Uraba</i>	<i>lugens</i> Walker	6.5	449	12.2	460	9.1	223			Allen and Keller 1981
				11.5	453	9.3	226			Allen and Keller 1981 M
				13.2	453	9	218			Allen and Keller 1981 F
<i>Vanessa</i>	<i>kenshawii</i> McCoy			14.4	160.7	15.5	78.1			James 1987 P
				10.3	225.1	15.1	68.8			James 1987 P
<i>Zenopsis</i>	<i>coffea</i> Netter	12.2	130.4	12	1408.9	11.6	302.7			Chang 1987
Neuroptera										
<i>Anomalochrysa</i>	<i>frater</i> Perkins	9.1	61.4	6.6	213.1	6.1	249.6	7	522.3	Tauber et al 1992
<i>Anomalochrysa</i>	<i>maculachlan</i> Blackburn	9.5	50.4	9.8	222.9	10.3	112.9	9.9	385.7	Tauber et al 1990
<i>Cundochrysa</i>	<i>jubigensis</i> (Holzel)	13.7	44.3	16.9	106.5	15	59.6	16.2	201.5	Chakrabarti et al 1991 T
		13.7	48.5	17	112.7	15.8	55.1	16.3	212.1	Chakrabarti et al 1991 T
		14.4	48	16.8	127.3	15.86	57.6	16.3	229.1	Chakrabarti et al 1991 T
<i>Microgaster</i>	<i>tasmaniae</i> (Walker)	1.7	128.1	5.7	111.1	4.3	195.3	4.3	427.3	Syrett and Penmann 1981

Genus	Species	Egg		Larva		Pupa		Total		Reference
		LDI	SET	LDI	SET	LDI	SET	LDI	SET	
Odonata										
<i>Enallagma</i>	ebrium (Hagen)	12,5	192,9							Pilon 1982
<i>Enallagma</i>	veniale Gloyd	12	204,8							Pilon 1982
<i>Leucosternus</i>	glacialis Hagen	14,7	132,1							Pilon et al. 1989
Orthoptera										
<i>Aulocara</i>	elliotti (Thomas)			18,1	341,6					Kemp and Dennis 1989
<i>Chortogonus</i>	lugubris Blanchard	10,8	557,7							Ibrahim 1971
<i>Chortocetes</i>	terminifera Walker	14,6	288,7	20,1	289,7			19,6	460	Grigg 1983
<i>Eyprepocnemis</i>	alacris Serville	13,9	318,3	17,6	884,5			18,9	980,8	Khan and Aziz 1974 M
				18,6	933,7			16,1	1239,4	Khan and Aziz 1974 F
<i>Gryllus</i>	commodus Walker	16	143,4							Browning 1952
<i>Melanoplus</i>	femurubrum (DeGeer)			20,8	382,2					Bellinger & Penkowski 1989 D
<i>Monstria</i>	discrepans (Walker)			18,7	578					Allsopp 1977 M
				17,7	590,2					Allsopp 1977 F
<i>Plebeogryllus</i>	gutiventris Walker			13,5	791					Dekshayani and Mathad 1973
<i>Ruspolia</i>	differens (Serville)	15,1	256,4							Hartley and Ando 1988
<i>Spathosternum</i>	praeniferum Walker	15	359,9							Iqbal and Aziz 1973
<i>Zabalius</i>	apicalis Solivar	0,7	502,6							Ekawa 1975
Siphonaptera										
<i>Ctenocephalides</i>	felis (Bouché)	8,2	42,3					11,4	404,2	Silverman et al. 1981
<i>Xenopsylla</i>	cheops Rothschild					11,2	228,8			Margalit and Shulov 1972 M
						11,4	187,5			Margalit and Shulov 1972 F
Thysanoptera										
<i>Frankliniella</i>	lusca (Hinds)	9,1	129,9	8,9	143,5			9	272,2	Lowry et al. 1992
<i>Frankliniella</i>	occidentalis (Pergande)			9,9	118,5			5,9	263,3	Lowry et al. 1992
<i>Gynaikothrips</i>	ficorum Marchal							6,9	406	Paine 1992
<i>Haplothrips</i>	victoriensis Bagnall	9	74,3	7,2	268,7			9,8	282,4	Andrewartha 1936
<i>Scirtothrips</i>	dorsalis Hood	8,2	178,4	8,6	136,2			8,3	313	Tatara 1994
<i>Thrips</i>	imaginis Bagnall	8,5	44,5	7,7	121,9					Andrewartha 1936
<i>Thrips</i>	obscuratus (Crawford)	4,9	66,9	4,1	152			4,2	218,9	Teulon and Penman 1991 M
		5	62,5	6,3	147,7			5,5	214,8	Teulon and Penman 1991 F
<i>Thrips</i>	fabaci Lindeman	12,9	87,5	10	115,6			11,5	178,2	Edelson and Nagaro 1986

Revision of some Oriental *Mordellini* with description of three new species
Part 2. (Coleoptera: Mordellidae)

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Abstract. *Yukahananomia tui* sp. n. from Vietnam, *Klapperichmorda kodada* sp. n. from Sarawak and *Varumorda* (s. str.) *shiyake* sp. n. from Vietnam are described. The following new combinations are proposed: *Klapperichmorda geniculata* (Pic, 1928), *Varumorda* (s. str.) *celebensis* (Pic, 1923) are transferred from *Mordella* L., 1758 and *Varumorda* (s. str.) *longevittata* (Pic, 1925) from *Mordellistena*.

Taxonomy, Coleoptera, Mordellidae, Oriental region

INTRODUCTION

The present paper results from the gradual study of a rich material of Mordellidae collected by Czech entomologists in Southeast Asia in the last years and from the revision of the types of species described by Maurice Pic and deposited in the Muséum national d'Histoire naturelle, Paris. As in the preceding paper (Horák 1995), author aims to treat some groups as a whole in order to facilitate their future study. This approach will result in the series of papers with equal heading in future.

ACRONYMS

CHP Horák collection, Prague
MNHN Muséum national d'Histoire naturelle, Paris

SYSTEMATICS

Yukahananomia tui sp. n. (Figs 1–5)

MATERIAL EXAMINED. Holotype, female (CHP), N. Vietnam, Sa Pa, 1600m, 11–16.5.1990, J. Horák leg.

DESCRIPTION OF FEMALE. Parallel-sided and little convex, widest at the base of pronotum (Fig. 1). Black, anteclypeus yellowish, postclypeus, anterior margin of labrum and the base of mandibles red-brown. Pubescence of dorsal surface black except for silvery hairs on scutellum. On ventral surface, pubescence of anterior and posterior portions of mesosternum and posterior margins of abdominal sternites whitish, otherwise black. Tips of pygidium and hypopygium with golden pubescence.

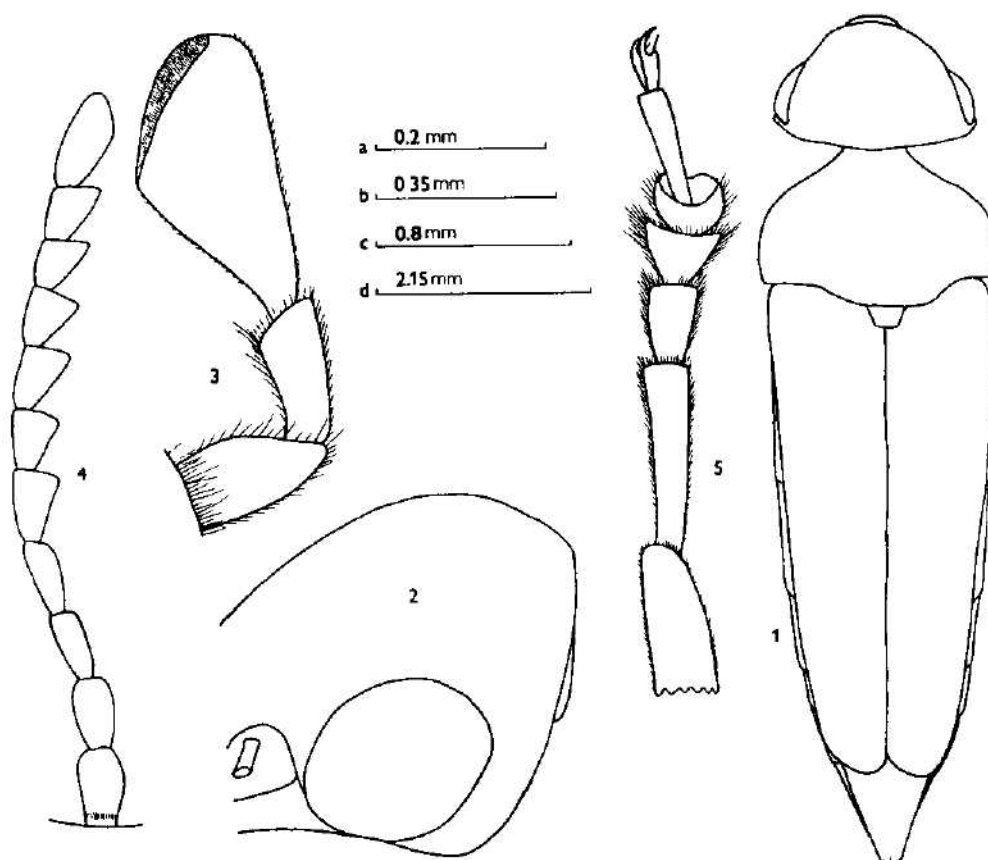
Head flatly convex, maximum width to maximum length ratio 13 : 10, distinctly impressed in the middle of frons. Anterior margin of frons gently swollen at insertions of antennae, concave against anteclypeus. Anterior margin of labrum straight. Eyes (Fig. 2) comparatively small, broadly oval, very finely faceted, glabrous. Temples strongly developed. Entire surface of the

head coarsely and densely punctate. Maxillary palpus (Fig. 3) with second and third segments equally broad; the third segment 1.8 times longer than wide; terminal segment elongate-securiform, comparatively thick, its outer impressed and pubescent surface oval. Antenna short, finely serrate (Fig. 4).

Pronotum somewhat wider than the head or elytra, flatly convex, very broad, maximum width to maximum length ratio 13.4 : 9.5. Its anterior margin with collar-shaped prolongation, posterior lobe flat and very broad. Sides in lateral view gently arcuate, posterior angles obtusely rounded. Punctuation very coarse, basal half distinctly transversely rugose.

Scutellum broadly quadrangular with rounded posterior corners. Elytra beginning from humera feebly conical, more strongly narrowed in their apical third, very broadly separately rounded at the apex, 2.23 times longer than their combined width, very coarsely and rugosely punctate.

Pygidium flat, very broadly conical, with distinct raised mediolongitudinal edge, broadly truncate at the apex, by one fourth longer than hypopygium.



Figs 1-5. *Yukahananomia tui* sp. n. (Holotype, female): 1 - general view; 2 - eye; 3 - maxillary palpus, 4 - antenna, 5 - anterior tarsus. Scale: a - 3, b - 4, 5, c - 2; d - 1.

Anterior tarsi (Fig. 5) somewhat shorter than fore tibiae, becoming gradually wider from the first to the fourth segment; the first segment as long as the three following ones together; the fourth segment quadrate, emarginate to its midlength, with emarginate onychium on ventral surface; terminal segment twice as long as the fourth one. Middle tarsi longer than mesotibiae. Metatibia only with one apical ridge, which is parallel to apical margin of tibia and reaches one fourth of its width. Posterior tarsi without ridges. Outer terminal spur of metatibia distinctly thinner than the inner one and hardly reaching one third of its length.

Length from tips of mandibles to apex of elytra 6.8 mm, to apex of pygidium 8.7 mm.

DIFFERENTIAL DIAGNOSIS. For the differentiation see the key to Oriental species of *Yukahananomia* below.

ETYMOLOGY. Dedicated to our Vietnamese guide, Mr Duong Tat Tu, who accompanied us on the collecting trip to northern Vietnam.

Key to Oriental species of *Yukahananomia* Kôno, 1935

- 1(2) Completely black. Pubescence of dorsal surface black except for the silvery hairs on scutellum. Ventral surface with black pubescence, only anterior and posterior portions of mesosternum as well as posterior margins of abdominal sternites with silvery hairs. Apex of pygidium and hypopygium with golden pubescence. Length 8.7 mm. N. Vietnam *Y. tai* sp. n.
- 2(1) Body black, pubescence golden with striking pattern of black hairs.
- 3(4) Vertex indistinctly convex. Head, pronotum and elytra with brightly golden-yellow pubescence. Black transverse spot behind the midlength of elytra completely separated from the apical one. Each abdominal sternite with distinct spots of black hairs in the middle of its posterior margins. Length 10.5–11.2 mm. Japan, Maritime Province of Russia (Primorie), China (Chansi) *Y. yakui* Kôno, 1930
- 4(3) Vertex distinctly convex, with dark rusty pubescence. Pronotum and elytra with dark golden-yellow pubescence. Black postmedian spot of elytra narrowly connected with the apical one. Pygidium almost entirely covered with dark rusty pubescence. Abdominal sternites without black spots in the middle of posterior margins. Length 7.8–8.8 mm. Japan (Honshu) *Y. tsuyuki* Takakuwa, 1978

Klapperichimorda geniculata (Pic, 1928) comb. n. (Figs 6–9)

Mordella geniculata Pic, 1928: 13.

MATERIAL EXAMINED. Holotype, female (MNHN), Hoa Binh, bearing red label „Type“ and an additional label „*Mordella geniculata* n. sp.“. Present designation by the author.

REDESCRIPTION OF FEMALE. Body brown-black, ante- and postclypeus, labrum, base of mandibles, maxillary palpi, antennae, anterior legs, intermediate femora and terminal spurs of metatibiae yellow-brown. Pubescence of elytra black except for four grey-white spots (Fig. 6).

Head rather flatly convex, maximum width to maximum length ratio 7.2 : 5. Eyes broadly oval, very finely faceted and pubescent. Neither temples nor temporal angles developed. Maxillary palpus (Fig. 7) with second and third segments almost equally wide; terminal segment broadly securiform, with inner corner shifted distally. Antennae (Fig. 8) rather short, the first segment by one third longer and slightly wider than the second one; the third segment as long as but distinctly narrower than the second; segments fourth to tenth becoming gradually smaller, each of them nearly twice as long as wide; terminal segment shortly oval, 1.3 times longer than wide and slightly longer than the preceding one.

Pronotum rather flatly convex, maximum width to maximum length ratio 9 : 6.5, with distinct collar-shaped anterior prolongation. Sides in lateral view quite straight, posterior angles broadly obtusely rounded.

Scutellum small, triangular.

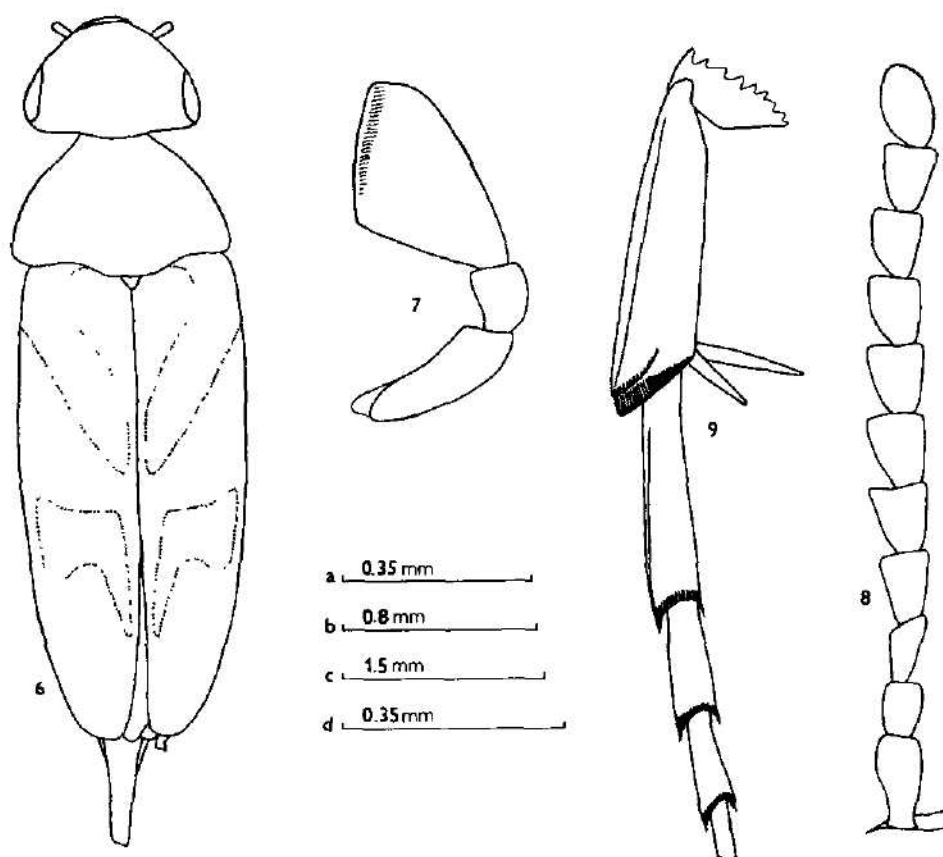
Elytra moderately convex, with only moderately arcuate sides, 2.2 times longer than their combined width, narrowly separately rounded at the apex.

Pygidium narrowly conical, twice as long as hypopygium, without the ring of light hairs at the base.

Anterior tarsi reaching nearly two thirds of the length of anterior tibiae. The first segment of anterior tarsus as long as the following ones combined; the third segment truncate; the fourth one deeply emarginate with truncate onychium on its ventral side; terminal segment twice as long as wide and twice as long as the fourth one. Intermediate tarsi as long as mesotibiae. Metatibia (Fig. 9) besides apical ridge with one very distinct dorsal ridge. The first segment of posterior tarsus with one distinct dorsal ridge, following segments without ridges. Outer terminals spur of metatibia reaching one third of the length of the inner one.

Length from tips of mandibles to apex of elytra 5.0 mm, to apex of pygidium 6.0 mm.

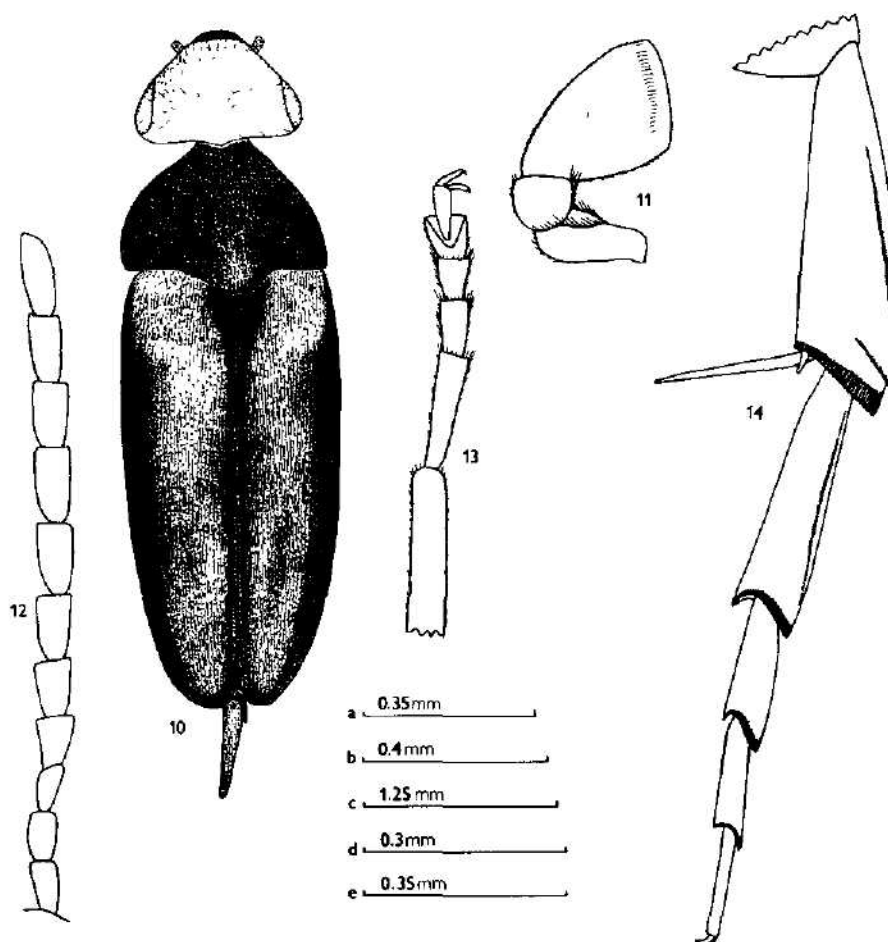
Male unknown.



Figs 6-9 *Klapperichmorda geniculata* (Pic) (Holotype, female): 6 - general view; 7 - maxillary palpus; 8 - antenna; 9 - posterior tibia and tarsus. Scale: a - 8, b - 9; c - 6; d - 7.

Key to known species of *Klapperichimorda* Ermisch, 1968

- 1(2) Elytra completely black, becoming somewhat lighter at the base. Pubescence of elytra black except for grey humeral and postmedian spots on each elytron. Antennae of female short, each of the segments fourth to tenth 1.2 times longer than wide. N.Vietnam *K. geniculata* (Pic, 1928)
- 2(1) Elytra bicoloured with black pubescence on black background and golden-yellow pubescence on light spots.
- 3(4) Black, only anterior portion of head, antennae, maxillary palpi, fore legs, middle femora, terminal spurs of hind tibiae and four spots on elytra yellow- to red-brown. Outer terminal spur of metatibia reaching one third of the length of the inner one. China (Fujian), N.Vietnam *K. quadrimaculata* Ermisch, 1968
- 4(3) Yellow-brown, only pronotum, scutellum, suture and sides of elytra, anterior portion of mesosternum and lateral portions of abdominal segments black. Outer terminal spur of metatibia very small, reaching only one tenth of the length of the inner one. Antennae of female rather long, each of the segments fourth to tenth 1.5 times longer than wide. Malaysia (Sarawak) *K. kodadai* sp. n.



Figs 10-14. *Klapperichimorda kodadai* sp. n. (Holotype, female): 10 - general view; 11 - maxillary palpus; 12 - antenna; 13 - anterior tarsus; 14 - posterior tibia and tarsus. Scale: a - 12; b - 14; c - 10; d - 13; e - 11.

Klapperichimorda kodadai sp. n. (Figs 10–14)

MATERIAL EXAMINED. Holotype, female (CHP), Sarawak (Borneo), ca 25 km E Kapit, 3.1994, J. Kodada leg.

DESCRIPTION OF FEMALE. Bicoloured species (Fig. 10). Entire head including appendices yellow-brown, pronotum and scutellum black, elytra yellow-brown with broad lateral and narrow sutural black stripes. Ventral surface yellow-brown, anterior portion of mesosternum and lateral portion of abdominal sternites black. All legs yellow-brown.

Head flatly convex, maximum width to maximum length ratio 6.1 : 5.3, somewhat projecting posteriorly in the middle. Eyes broadly oval, very finely faceted and pubescent. Temples absent, only little distinct temporal angles developed on ventral side. The first and second segments of maxillary palpus equally broad, terminal segment rather broadly securiform, its inner corner shifted into the second third of the segment length (Fig. 11). Antennae (Fig. 12) comparatively short, the first segment by one fourth longer than and as broad as the second; the third segment conical, by one third shorter and distinctly narrower than the second one; the fourth segment by one third longer and broader than the third one; segments fourth to tenth becoming gradually narrower, 1.4 (segment fourth) to 1.6 (segment tenth) times longer than broad; terminal segment oblong oval, almost twice as long as wide and as wide as the preceding one.

Pronotum flatly convex, distinctly wider than long, ratio 7.5 : 6, with distinct collar-shaped anterior prolongation; posterior margin straight with a well developed posterior lobe, posterior angles broadly obtusely rounded.

Scutellum small, triangular, with black pubescence.

Elytra rather convex, in basal half almost parallel-sided, relatively narrow, 2.12 times longer than their combined width, rather narrowly separately rounded at the apex.

Pygidium very thin, 2.3 times longer than hypopygium.

Anterior tarsi (Fig. 13) distinctly shorter than anterior tibiae, the first segment only little shorter than the following ones combined; the third segment slightly longer than broad, truncate; the fourth segment deeply emarginate (approximately in three fourths of its length) with gently emarginate onychium on the ventral side; terminal segment very short, as long as the fourth one (overlapping it by one half of its length) and twice as long as broad. Middle tarsi slightly longer than middle tibiae. Metatibia (Fig. 14) besides apical ridge with one distinct dorsal ridge. The first segment of posterior tarsus also with one ridge, remaining segments smooth. Outer terminal spur of metatibia reaching only one tenth of the length of the inner one, and also distinctly narrower.

Length from tips of mandibles to apex of elytra 4.5 mm, to apex of pygidium 5.2 mm.

Male unknown.

DIFFERENTIAL DIAGNOSIS. For the differentiation see key to know species of *Klapperichimorda* above.

ETYMOLOGY. This new species is dedicated to my friend, Slovak entomologist Dr Ján Kodada (Bratislava), who took part in our collecting trip to Borneo.

Variimorda (s. str.) *celebensis* (Pic, 1923) comb. n. (Figs 16–19)

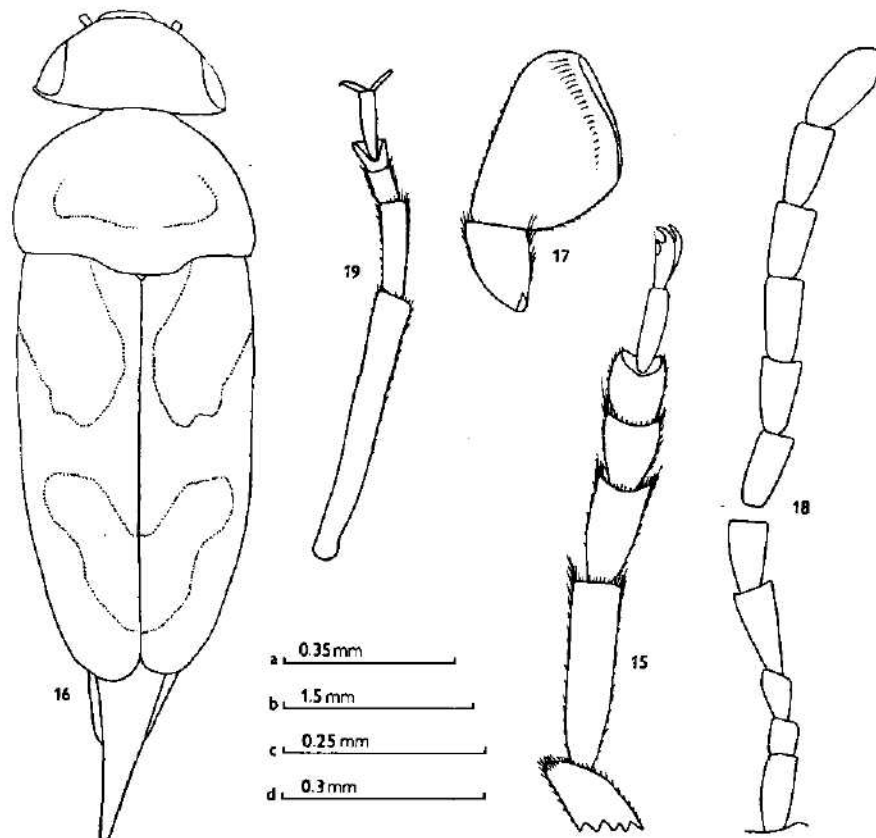
Mordella celebensis Pic, 1923: 30

MATERIAL EXAMINED. Holotype, female (MNHN), Ost Celebes, Tombugu, 1885, H. Kühn. Present designation by the author.

REDESCRIPTION OF FEMALE. Comparatively short and rounded species (Fig. 16). Black with broad red-brown humeral band on each elytron, reaching almost the midlength of elytra. Anterior portion of frons, anteclypeus, labrum, base of mandibles, maxillary palpi, antennae, intermedi-

ate legs, posterior tarsi and terminal spurs of metatibiae lighter, yellow- to red-brown. Pubescence of dorsal surface gray-black except for golden yellow pubescence at the base of pronotum, on humeral spots and behind the midlength of elytra, where the yellow pubescence makes up a V-shaped spot on black background. Pubescence of ventral surface also black-grey except for the anterior portion of mesosternum and bases of all abdominal sternites (excluding hypopygium), where the pubescence is silvery.

Head rather large, flatly convex, maximum width to maximum length ratio 8.5 : 6.3, only moderately prolonged in the oral portion. Anterior margin of clypeus straight. Eyes oblong oval, narrowed towards the insertion of antenna (antennal pit), very finely faceted and pubescent. Neither temples nor temporal angles developed. Second segment of maxillary palpus only slightly wider than the third one, terminal segment broadly securiform, its inner corner situated at one third of the segment's length, strongly rounded (Fig. 17). Antennae rather long, only indistinctly serrate, form of particular segments as figured (Fig. 18).



Figs 15-19. *Variimorda* (s. str.) *sinensis* (Pic) (China, Yunnan): 15 - anterior tarsus. *Variimorda* (s. str.) *celebensis* (Pic) (Holotype, female): 16 - general view; 17 - maxillary palpus (3 and 4 segments); 18 - antenna; 19 - mesotibiae and middle tarsus. Scale: a - 18; b - 16; c - 17; d - 15, 19.

Pronotum flatly convex, maximum width to maximum length ratio 10.5 : 7.3. Anterior margin regularly arcuate, with only gentle collar-shaped prolongation. Posterior lobe broadly and flatly convex. Lateral margins in lateral view gently emarginate, posterior angles broadly obtusely rounded.

Elytra moderately convex, in basal half almost parallel-sided, 1.8 times as long as their combined width, separately rounded at the apex.

Pygidium regularly and rather narrowly conical, by one third longer than hypopygium.

Anterior legs missing in holotype. Mesotibiae (Fig. 19) as long as middle tarsi. The fourth segment of middle tarsus quadrate, as wide as the third one, emarginate in two thirds of its length and bearing a lightly emarginate onychium ventrally; the fifth segment slightly more than twice as long as the fourth one. Metatibia with only one apical ridge passing across one third of the width of tibia. Segments of posterior tarsus without ridges. Outer terminal spur of metatibia reaching one third of the length of the inner one.

Length from tips of mandibles to apex of elytra 5.0 mm, to apex of pygidium 6.2 mm.

Male unknown.

Key to the known species of *Variimorda* Méquignon, 1946 related to *V. sinensis* (Pic, 1917)

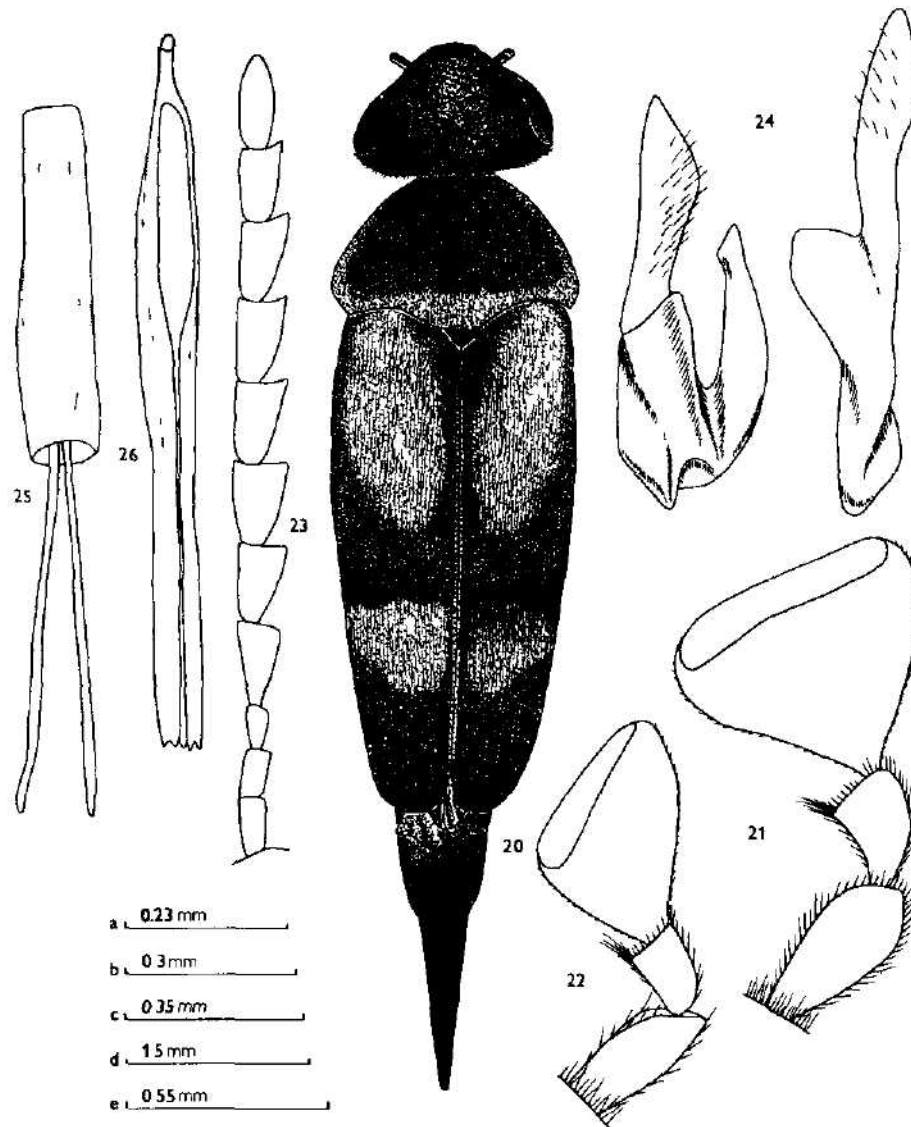
- 1(2) Penultimate segment of both fore and middle tarsus distinctly emarginate (Fig. 15), onychium indistinct. Anterior tarsi (male) or entire fore legs (female) and terminal segments of maxillary palpi black. Golden spots behind the midlength of each elytron small and round. Pygidium slender, in distal third parallel-sided. China (Yunnan), India (Bengal) *V. sinensis* (Pic, 1917)
- 2(1) Penultimate segment of both fore and middle tarsus deeply emarginate (Figs 19, 30), bearing a well developed onychium on its ventral side. Entire fore legs and maxillary palpi concolorous, yellow-brown. Golden spots behind the midlength of elytra large, either interconnected at suture to form a transverse band of variable shape, or confluent with humeral spot in longitudinal strip. Pygidium conical, regularly tapering towards the apex.
- 3(4) Whole three fourths of the length of elytra red-brown. Pubescence of elytra blackish except for a broad transverse humeral band at one third of the elytral length and a rather broad band behind the midlength of elytra, which are both golden-yellow. Anterior portion of frons in both sexes black. N. Vietnam *V. shiyakei* sp. n.
- 4(3) Only humeral band on each elytron red-brown, it either occupies only the basal third of elytron, or reaches almost to its apex. Anterior portion of frons lighter, reddish (little distinctly so in female of *V. celebensis*).
- 5(6) The red-brown humeral band rather large, reaching almost the midlength of elytra, covered with golden-yellow pubescence (Fig. 16). The same pubescence makes up also a V-shaped spot on the black background behind the midlength of elytra. Antennae (Fig. 18) thin (female), the fourth segment twice, each of the segments fifth to tenth about 1.5 times as long as wide. Indonesia (Sulawesi Isl.) *V. celebensis* (Pic, 1923)
- 6(5) The red-brown humeral band narrow, passing all along the elytron and terminated just before the apex, all with golden-yellow pubescence (Fig. 27). Antennae (Fig. 29) wider, each of the segments fourth to tenth only 1.3 times longer than wide (male). Indonesia (Batan Isl.) *V. longevittata* (Pic, 1925)

Variimorda (s. str.) *shiyakei* sp. n. (Figs 20–26)

MATERIAL EXAMINED. Holotype, male (CHP), N. Vietnam, pr. Vinh phu, Tam Dao, 3–11.6.1985, V. Švihla leg., Allotype, female (CHP), the same data. Paratypes: 1 female (CHP), the same data, but V. Kubán leg., 1 male (CHP), the same data, but A. Olexa leg., 1 male (CHP), the same data, but J. Picka leg., 5 ex. (CHP), the same data, but 27.–2.6.1986, J. Horák leg. (2 ex. in coll. S. Shiyake, Osaka), 1 male (CHP), the same data, but 13.–24.5.1989, A. Olexa leg.; 1 female (CHP), the same data, but 5.–10.6.1989, S. Brantlová leg., 1 female (CHP), the same data, but 20.–28.6.1990, M. Dvořák leg.; 1 female (CHP), the same data, but 17.–21.5.1990, J. Horák leg., 1 male (CHP), N. Vietnam, 75 km NW of Hanoi, Tam Dao, 900–1200 m, 21° 27' N 105° 39' E, 9–19.5.1996, L. Dembický et P. Pacholátka leg., 13 ex. (CHP) the same data, but 1–8.6.1996.

DESCRIPTION. Rather slender and rounded species (Fig. 20). Body black, elytra chestnut brown, becoming gradually darker posteriorly towards the almost black tips; moreover, each elytron bears two yellow-brown spots: elongate humeral one and a broad posterior one, situated at two

thirds of the elytral length. The latter spots of both elytra interconnected at suture. Mouth parts, bases of antennae, fore and middle legs as well as terminal spurs of metatibiae yellow-brown. Pubescence on the yellow-brown elytral spots golden-yellow, otherwise black-brown. Pubescence of ventral surface also black-brown, on the anterior portion of mesosternum and at the base of all abdominal segments including pygidium silvery.



Figs 20–26 *Varismorda* (s. str.) *shiyakei* sp. n. (Holotype, male) 20 – general view, 21 – maxillary palpus, 22 – maxillary palpus (Allotype, female), 23 – antenna, 24 – left and right paramere, 25 – phallobasis, 26 – penis. Scale a – 21, 22, b – 24, c – 25, 26, d – 20, e – 23.

Head black, flatly convex, maximum width to maximum length ratio 9 : 7. Oral portion moderately but distinctly prolonged, anterior margin of postclypeus shallowly emarginate. Eyes broadly oval, moderately narrowed towards the antennal pits, very finely facelled and relatively densely pubescent. Neither temples nor temporal angles developed. Second segment of the male maxillary palpus moderately dilated, distinctly wider than the third one; terminal segment broadly triangular with both basal margins of equal length, its outer side with long oval and finely pubescent impression (Fig. 21). Terminal segment in female broadly securiform, its inner basal margin reaching about two thirds of the length of the outer margin, inner corner rounded (Fig. 22). Antennae long and feebly serrate (Fig. 23), in female slightly shorter and narrower.

Pronotum rather convex with golden border all around, maximum width to maximum length ratio 10.5 : 8. Anterior margin regularly arcuate, posterior lobe broadly rounded. Lateral margins in lateral view slightly convex, posterior angles feebly obtusely rounded.

Scutellum comparatively small, triangular.

Elytra moderately convex, in basal half almost parallel-sided, almost twice as long as their combined width, broadly simultaneously rounded at the apex.

Pygidium elongate conical, gradually tapering posteriorly, somewhat less than twice as long as hypopygium.

Anterior tibiae distinctly longer than anterior tarsi, in males only slightly curved inwards, without a swelling and longer hairs at the base. The first segment of anterior tarsus as long as the three following ones combined; the third segment only very lightly emarginate; the fourth one with emargination reaching behind its midlength, bearing a shallowly emarginate onychium; terminal segment by one third longer than the fourth one; all segments of equal width. Middle tibia a little shorter than middle tarsus, the first tarsal segment a little longer than all following segments combined. Posterior tibia with only one apical ridge reaching one third of the width of tibia, segments of posterior tarsus without ridges. Outer terminal spur of metatibia reaching one half of the length of the inner one.

Male genitalia as figured (Figs 24–26).

Length from the tips of mandibles to apex of elytra 5.6–7.5 mm, to apex of pygidium 7.2–9.9 mm.

DIFFERENTIAL DIAGNOSIS. For the differential diagnosis see the key to the known species of *Variimorda* related to *V. sinensis* above.

ETYMOLOGY. The new species is dedicated to the Japanese entomologist, Dr Shigehiko Shiyake (Osaka Museum), specialist in the taxonomy of Mordellidae.

***Variimorda (s.str.) longevittata* (Pic, 1925) comb. n. (Figs 27–32)**

Mordellistena longevittata Pic, 1925: 12–13.

MATERIAL EXAMINED. Holotype, male (MNHN), Batjan, Labocan, II.III., Doherty. Present designation by the author.

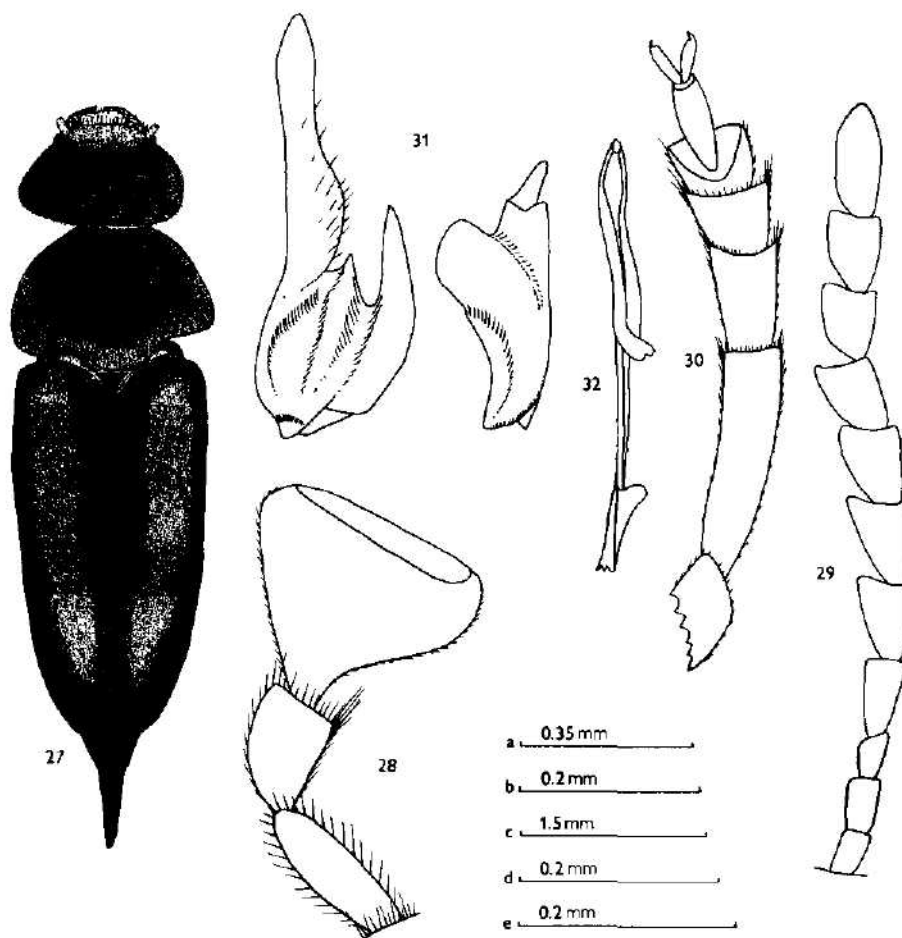
REDESCRIPTION OF MALE. Rather small, little convex and parallel-sided species (Fig. 27). Body bicoloured: black, long humeral bands running almost all along the elytra, anterior portion of frons and all appendices yellow-brown to brown.

Head comparatively large, rather strongly flatly convex, maximum width to maximum length ratio 7.4 : 6. Eyes broadly oval, narrowed towards antennal pits, very finely faceted and pubescent. Neither temples nor temporal angles developed. Second segment of maxillary palpus as wide as the third one; terminal segment (Fig. 28) very broadly securiform, both its basal margins almost equally long (inner one only slightly longer). Antennae (Fig. 29) of medium length,

rather broad; segments 1. and 2. of equal size; 3. minute, by one half shorter and by one fourth narrower than 2.; 4. nearly twice as long and by one third wider than 3.; 5. somewhat larger than 4. and 6., 1.3 times longer than wide; all segments beginning from the fifth one gradually diminishing, the tenth one only 1.2 times longer than wide; terminal segment (11.) oblong oval, almost twice as long as wide and by one third longer than the penultimate segment, narrowed towards the apex.

Pronotum flatly convex, distinctly wider than long, maximum width to maximum length ratio 9 : 6.2, anterior margin almost semicircular, collar-shaped prolongation very distinct. Posterior lobe narrow, flatly arcuate. Sides in lateral view straight, posterior angles very broadly obtusely rounded.

Scutellum comparatively large, triangular.



Figs 27–32. *Variimorda* (s. str.) *longevittata* (Pic), (Holotype, male): 27 – general view; 28 – maxillary palpus; 29 – antenna; 30 – anterior tarsus; 31 – paramere; 32 – penis. Scale: a – 29; b – 30, 32; c – 27; d – 28; e – 31.

Elytra only little convex, in basal third almost parallel-sided, twice as long as their combined width, separately rounded at the apex. Pubescence black, on the light humeral spots golden.

Pygidium narrowly conical, almost twice as long as hypopygium, without a ring of lighter pubescence at the base.

Anterior tibiae (Fig. 30) distinctly curved inwards, without swelling and longer outstanding hairs at the base, distinctly longer than anterior tarsi. The first segment of anterior tarsus as long as all following segments combined; the fourth segment emarginate in distal half and bearing truncate onychium on its ventral side; terminal segment by one third longer than the fourth one. Middle tibiae as long as middle tarsi. Posterior tibia with only one apical ridge passing through one third of the width of tibia, posterior tarsi without ridges. Terminal spurs of metatibia yellow-red, outer spur reaching the midlength of the inner one.

Male genitalia as figured (Figs 31–32).

Length from the tips of mandibles to apex of elytra 4.9 mm, to apex of pygidium 5.8 mm.

Female unknown.

Acknowledgements

I wish to express my thanks to Claude Girard (MNHN), who enabled me to study the Pic's type specimens in his charge. Moreover, I am obliged to the Slovak entomologist Ján Kodada, as well as to many Czech entomologists, who provided me with the material upon which this paper is based.

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Demographic analyses of *Canis lupus* population in Slovakia during the period 1983–1990 (Mammalia: Carnivora)

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Abstract Using results of a long-term questionnaire program, changes in the distribution of wolves in Slovakia within the period 1983–1990 were evaluated on the base of hunted animals, the population densities in different regions, the proportion between sexes and between adult and juvenile and some data concerning food composition were obtained. Some biometrical parameters of Slovakian population (snout-vent length, tail length, length of the ear, height at shoulder and weight) were counted. In the course of the monitored period wolves were gradually spreading from the area neighbouring with the Polish and Ukrainian borderlines in the south and south-west and the density of local subpopulations were growing. Till the year 1990 the majority of Slovakian mountain ranges had been occupied. The large proportion of young animals in the killings of hunters gives evidence about the vitality of this population. The adult males reached greater dimensions in all surveyed biometrical parameters than females (mean weight 41.7 vs. 38.0 kg, mean snout-vent length 137.1 vs. 128.7 cm, mean tail length 43.8 vs. 41.2 cm, mean height at shoulder 77.5 vs. 72.6 cm, mean length of ear 11.6 vs. 11.1 cm). The relations between the weight and snout-vent length and between the weight and the height at shoulder are linear for both sexes. The red deer, roe deer and wild boar were the most frequent items of the wolves diet.

Biometry, demography, diet, distribution, wolf, *Canis lupus*, Slovakia

INTRODUCTION

The occurrence of large mammals in heavily inhabited regions of Europe is strongly influenced by anthropic factors. These animals are mostly forced into extensive mountainous regions. The Carpathian mountains, the home of the strong wolf (*Canis lupus* Linné, 1758) population, is a good example of this situation. The western border of their continual distribution in Europe is situated just inside the Slovakian part of these mountains. The heavily inhabited lowland regions prevent wolf populations from spreading in western and south-western directions. In spite of the fact that wolves have been living here traditionally in close proximity to people, well documented data about the biology, the biometry or the geographical distribution of this species are not too numerous. Craniometrical data has been processed by Hell (1972). The geographical distribution and conservation has been mentioned in various works including Feriancová-Masárová (1955), Feriancová-Masárová & Hanák (1965), Hell (1974), Voskár (1976). This work will attempt to build upon the results of these authors by processing data from a later period (1983–1990). It is concerned partly with changes of the wolves distribution in Slovakia and partly with the biometrical parameters of this population. Data about the size and composition of the population and about food composition of wolves are mentioned only on peripherally.

METHODS

Data used in this work originated in the long-term questionnaire program of the Hunting Society of Slovakia and they are connected with the paying of financial rewards (terminated in 1990) for killing wolves. For this reason it is clear that not all cases of killed wolves are recorded here, but only those for which hunters claimed a financial reward. Every hunter had to complete the questionnaire concerning hunting conditions (correct locality, time and method) and the killed wolf (sex, age, weight, body measures, content of the stomach). Together with this data, the skull had to be produced for verification. It is understandable that data obtained in this way suffers partly from the inaccuracy, but considering that the material was so extensive and that there is no other possibility to collect data from this region, the results provide a sufficient summary of the observed data. The picture of the overall distribution of wolves in individual years arose by plotting the locations of killings onto grid maps of the former ČSFR. Rectangles, created by dividing the whole territory by the grid of co-ordinates, have a real area 134 km² (11 2×12 0 km) (Novák 1989). Data about the population density in individual regions were obtained by comparing the differences in the number of killed wolves among these rectangles. The total number of killed wolves per given year without any other specification originated from statistics of local hunting associations which were sent to the board of the Hunting Society of Slovakia.

This paper also includes biometrical data of the snout-vent length, tail length, length of the ear, height at shoulder and weight of the wolves. The mean value together with standard deviation, the number of measurements and extent of values are recorded. Relations between the weight and snout-vent length, between the weight and the height at shoulder, between the height at shoulder and the snout-vent length are described in both sexes graphically and by means of regression equations. The frequency distribution of categories of these values in the population is demonstrated graphically. The measurement of parameters was practised by hunters on shot animals (Fig. 1). The snout-vent length means the straight distance between the snout and tail base, the tail length means the straight distance between the tail base and its tip (including hairs), the length of ear means the straight distance between the base and its tip (including hairs) and the height at shoulder means the straight distance between the distal end of the fore limb in its natural position and the shoulder part of the back. All weights given include the bowel weight. While mean values of these characteristics concern only adult wolves of both sexes, regression and frequency distribution analyses contain data about the whole population including juvenile wolves. Biometrical data was analysed using PC program STATGRAPHIC.

Data about the proportion of males and females, adult and juvenile animals in catches of hunters are processed in the demographic passage. The examinations of the skulls were conducted by the Forestry Research Institute in Zvolen and the weights of wolves were used for distinguishing young wolves from adult ones. A weight above 33 kg, which is generally reached by wolves after finishing their first year of life (Hell 1974) forms the boundary.

109 noncontroversial stomach analyses of hunted wolves show the frequency distribution of food components in the quarry of wolves.

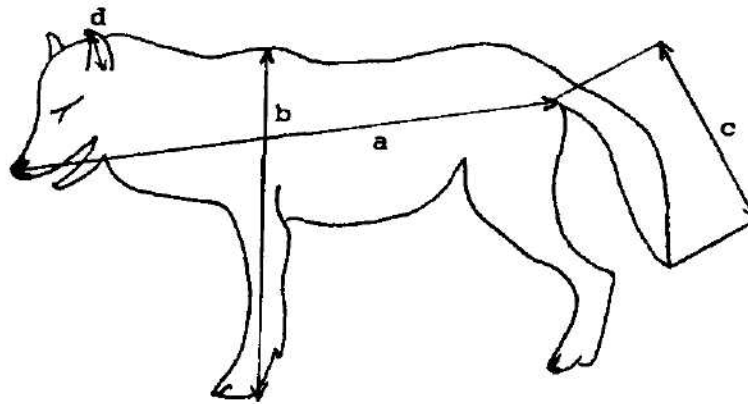


Fig. 1 Method of body scales measurement a) snout-vent length, b) height at shoulder, c) tail length, d) length of the ear

RESULTS

The area of distribution (1983–1990)

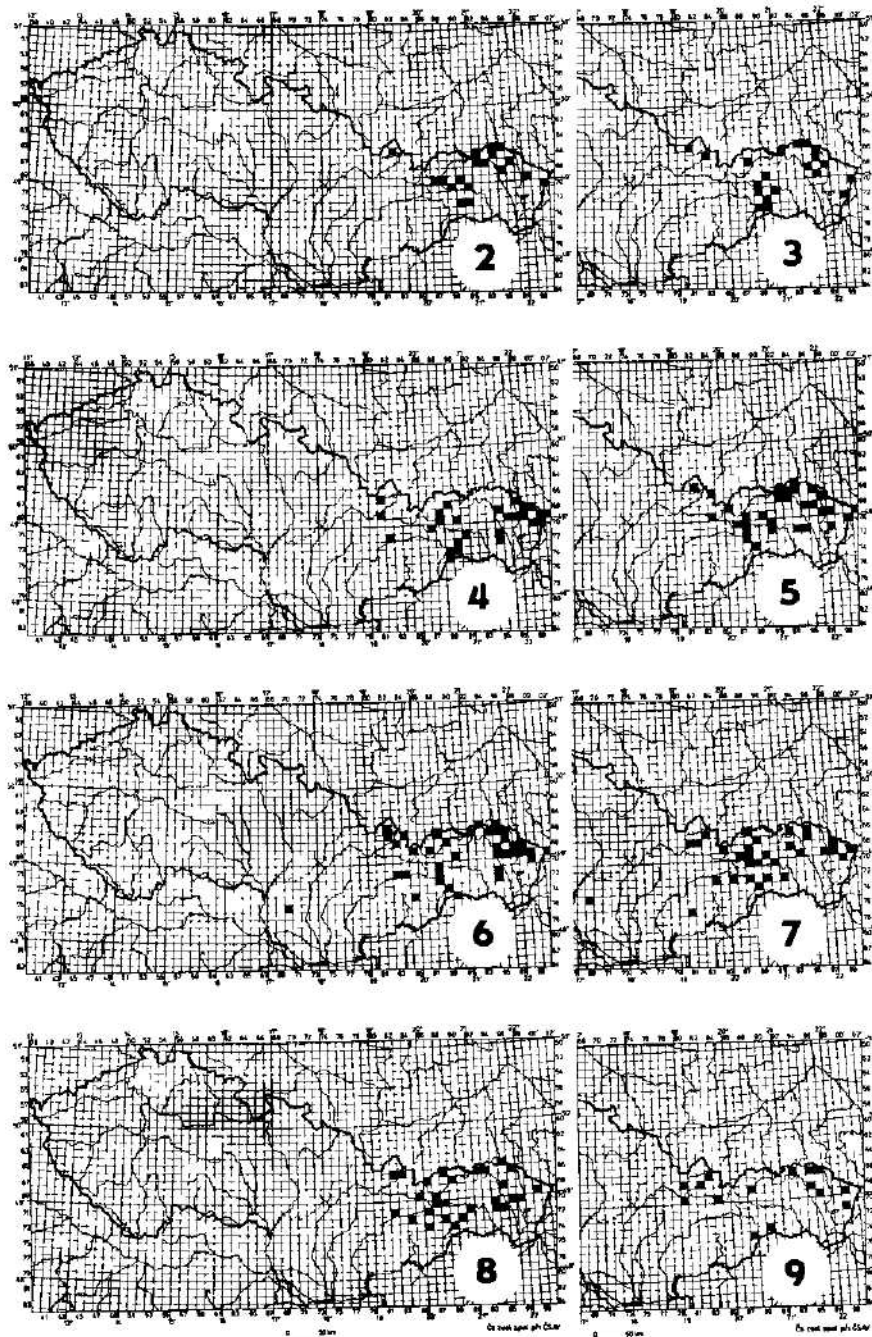
For this period an increasing area of land was occupied by wolves. This positive trend, having started in the middle of the seventies, halted the period of decline having culminated around the year 1973.

In the year 1983 wolves inhabited the whole area of the Nízke Beskydy mountain range, the northern part of the Čergov mountains, the area of the upper and middle Hornád River (the Spiš region), the south of the Levočské vrchy Hills, the eastern part of the Slovenské Rudohorie mountain range and the area of Orava (Fig. 2). One year later (1984) wolves were also found in the east of the Vihorlat Hills, in the Slovenský Kras karst, in the area eastward of the Vysoké Tatry mountains and around the upper half of the Ondava River (Fig. 3). It is likely that the wolves came from this area into the Slánské vrchy Hills (1985). From the same year data was also gathered about their occurrence at the Silická planina plain, where they penetrated from the east of the Slovenské Rudohorie. The global distribution was confirmed in the Levočské vrchy hills. The area of confluence of the rivers Orava and Váh and the southern slopes of the western part of the Nízke Tatry mountains were occupied by wolves from the Orava region (Fig. 4). From 1986 there is data about their occurrence in the Vysoké Tatry mountains and in localities around the confluence of the rivers Biely and Čierny Váh (Liptov) (Fig. 5). The following year (1987) population density growth is apparent in the whole area of the Nízke Beskydy mountain range together with following expansion inland. They are also known in the western and central part of the Slovenské Rudohorie hills. All the time they have been occupying southern slopes of the Nízke Tatry mountains and in the area between the Vysoké Tatry mountains and the Orava region it is possible to talk about their continual distribution. The occurrence of wolves in the central part of the Malé Karpaty mountain range is certainly strange. It is the most western locality in Slovakia (Fig. 6). This small group of wolves still lived here the following year (1988), but afterwards the whole pack was destroyed. From this year data about the occurrence of wolves appeared in area of the Pol'ana – Javorie hills (Fig. 7). In 1989 they were found out in the regions Vranov above the Toplá River (Fig. 8) and the following year (1990) as far north as the Malá Fatra mountains (Fig. 9).

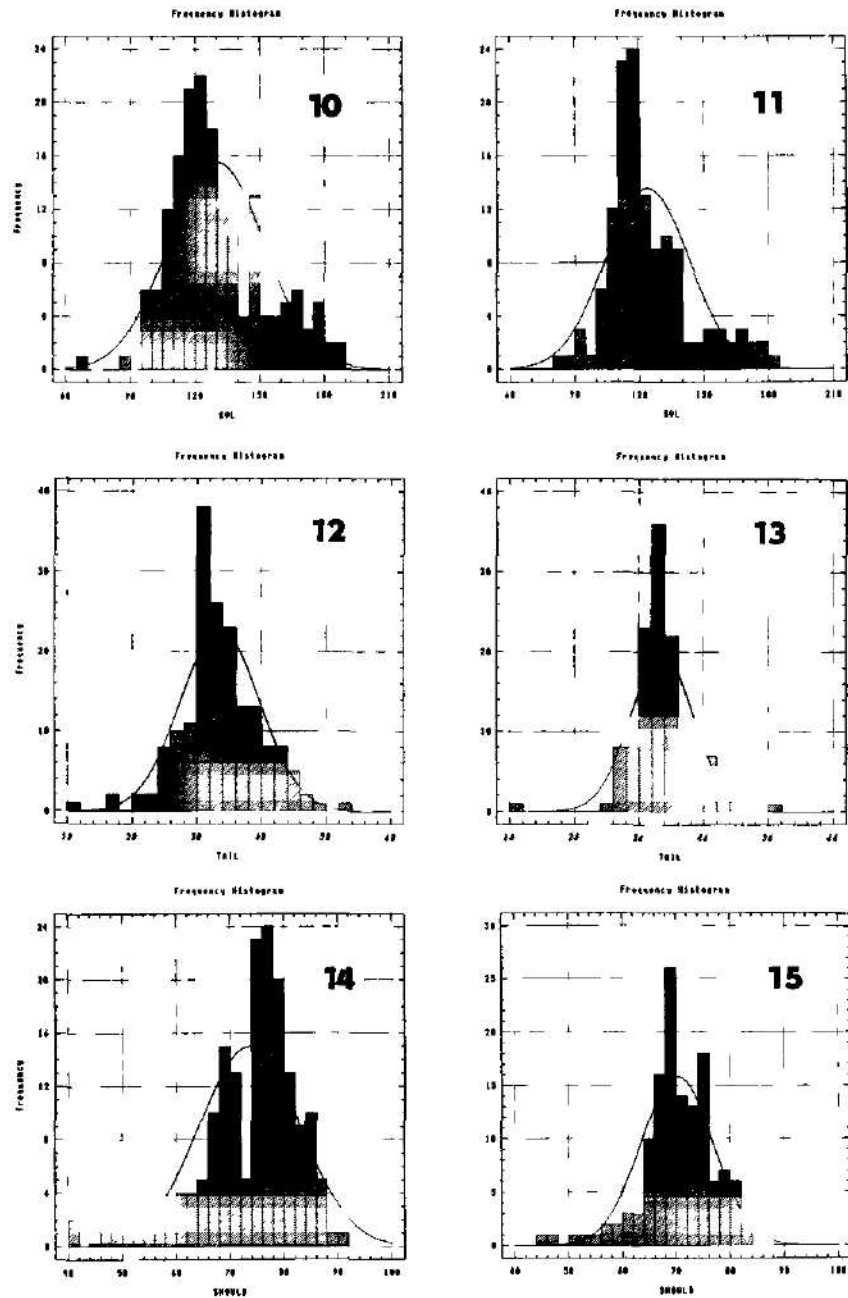
It arises from previous data, that the area of distribution was growing from the northeast and the mountain areas were gradually settled by wolves in the south and south-west. They had come back into the majority of the mountain ranges by 1990. The highest population density within the period 1983–1990 was in the Nízke Beskydy region particularly in the border area with Poland, in the eastern half of Slovenské Rudohorie and in the Spiš region. Also their occurrence in the Orava region was not an exception.

Biometrical data

Within the period 1984–1990 the mean snout-vent length was taken from a sample of 119 adult males and 61 adult females, the mean tail length from a sample of 120 adult males and 59 adult females, the mean length of ear from a sample of 116 adult males and 60 adult females, the mean height at shoulder from a sample of 116 adult males and 59 adult females and the mean weight from the sample of 136 adult males and 66 adult females. The frequency distribution of categories of these values is shown in figures 10–19 for both sexes. The most frequent male categories are as follows: the snout-vent length around 120 cm, the tail length 38–44 cm, the length of ear 11–12 cm, the height at shoulder 74–80 cm and the weight 34–36 kg. Wolves weighing 38–46 kg are also very numerous. The most frequent female categories are following:



Figs 2-9. Areas with killed wolves in 1983-1990 (1990 - only first half of year is included)



Figs 10–15 Frequency histograms of snout-vent length – males (10) and females (11), tail length – males (12) and females (13), height at shoulder – males (14) and females (15)

Tab 1 Demographic composition of Slovakian wolf population based on killed wolves

Year	Adults	Juveniles	Males	Females
1984	20 (64.5%)	11 (35.5%)	17 (60.7%)	11 (39.3%)
1985	38 (67.9%)	18 (32.1%)	36 (60.0%)	24 (40.0%)
1986	35 (69.6%)	20 (36.4%)	31 (55.4%)	25 (44.6%)
1987	38 (55.1%)	31 (44.9%)	41 (58.6%)	29 (41.4%)
1988	38 (59.4%)	26 (40.6%)	38 (56.7%)	29 (43.3%)
1989	21 (65.6%)	11 (34.4%)	22 (56.7%)	11 (33.3%)
Sum	190 (61.9%)	117 (38.1%)	185 (58.9%)	129 (41.1%)
Year	Ad. males	Juv. males	Ad. females	Juv. females
1984	3 (72.2%)	5 (27.8%)	7 (50.0%)	7 (50.0%)
1985	29 (82.9%)	6 (17.1%)	9 (40.9%)	13 (59.1%)
1986	22 (73.3%)	8 (26.7%)	13 (52.0%)	12 (48.0%)
1987	25 (62.5%)	15 (37.5%)	13 (46.4%)	15 (43.6%)
1988	26 (72.2%)	10 (27.8%)	12 (48.0%)	13 (52.0%)
1989	12 (54.2%)	10 (45.4%)	8 (80.0%)	2 (20.0%)
Sum	127 (70.2%)	54 (29.8%)	62 (50.0%)	62 (50.0%)

the snout-vent length around 115 cm, the tail length 36–42 cm, the length of the ear 9–12 cm, the height at shoulder 68–70 cm and the weight 30–32 kg

For both sexes the relation between the weight and snout-vent length is strongly linear. This relation is described for males by equation $Y=11.0968+0.2018 X$ ($r=0.5038$, $n=165$, $P<0.01$) (Fig. 20) and for females $Y=21.6160+0.0914 X$ ($r=0.3030$, $n=132$, $P<0.01$) (Fig. 21). The relation between the weight and the height at shoulder is even stronger. For males it is characterized by line $Y=-4.2550+0.5580 X$ ($r=0.5913$, $n=161$, $P<0.001$) (Fig. 22), for females by line $Y=7.9534+0.3523 X$ ($r=0.3523$, $n=129$, $P<0.001$) (Fig. 23). The relation between the height at shoulder and snout-vent length is not so clear. While for males the regression line $Y=74.0079+0.7496 X$ has the value of the correlation coefficient $r=0.3261$ ($n=162$, $P<0.01$) (Fig. 24), the correlation coefficient of the female regression line $Y=91.7689+0.4680 X$ is only $r=0.1532$ ($n=129$, $P=0.082$) (Fig. 25).

Adult males reach higher mean values in all observed measures compared with adult females. The difference in mean weight (41.7 ± 5.1 kg, $n=136$, max. 57.0 kg vs. 38.0 ± 3.0 kg, $n=66$, max. 48.5 kg) is significant ($P<0.01$). Also the difference in mean snout-vent length (137.1 ± 19.9 cm, $n=119$, range=105–188 cm vs. 128.7 ± 18.5 cm, $n=61$, range=83–180 cm) is significant ($P<0.01$). Significant differences were also found for tail length ($P<0.01$) (43.8 ± 5.5 cm, $n=120$, range=30–62 cm vs. 41.2 ± 4.0 cm, $n=59$, range=38–51) and for the height at shoulder ($P<0.01$) (77.5 ± 6.1 cm, $n=116$, range=63–90 cm vs. 72.6 ± 6.1 cm, $n=59$, range=60–84 cm). Only the length of the ear is not significant between sexes (11.6 ± 2.3 cm, $n=116$, range=7–19 cm vs. 11.1 ± 2.1 cm, $n=60$, range=7–17 cm). The Student t-test was used for all comparisons.

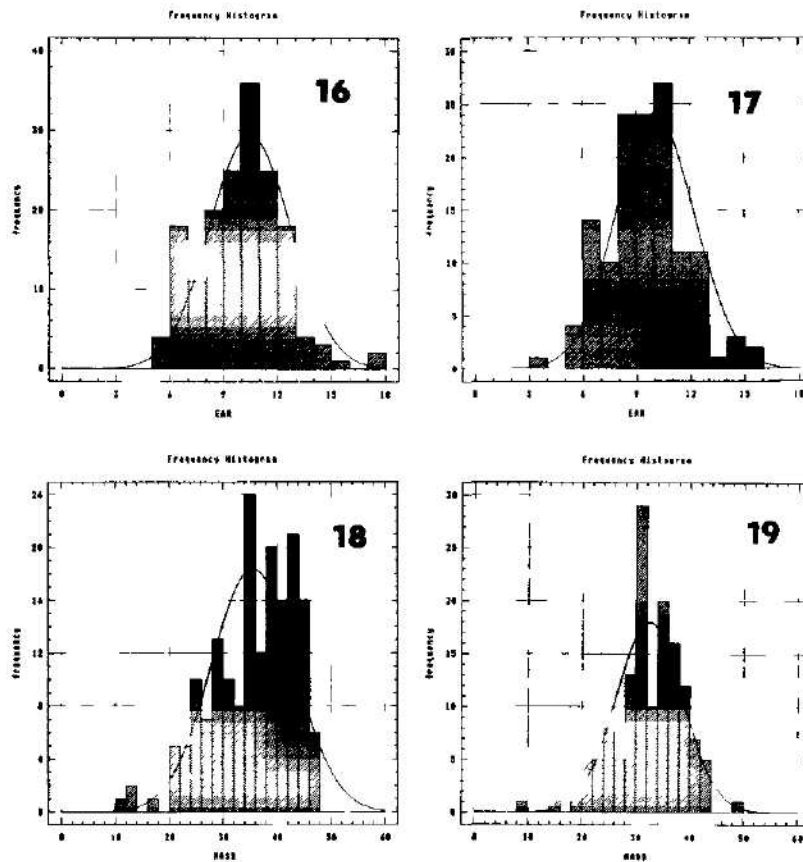
Composition of the population

Within the period 1984–1989 males dominated ($n=185$, 58.9%) in catches of hunters over females ($n=129$, 41.1%). This proportion was constant in all years (Tab. 1). While within these six years the proportion of young and adult females in catches was equal 62 (50%) to 62 (50%), adult males clearly dominated ($n=127$, 70.2%) over young ones ($n=54$, 29.8%) (Tab. 1). Juve-

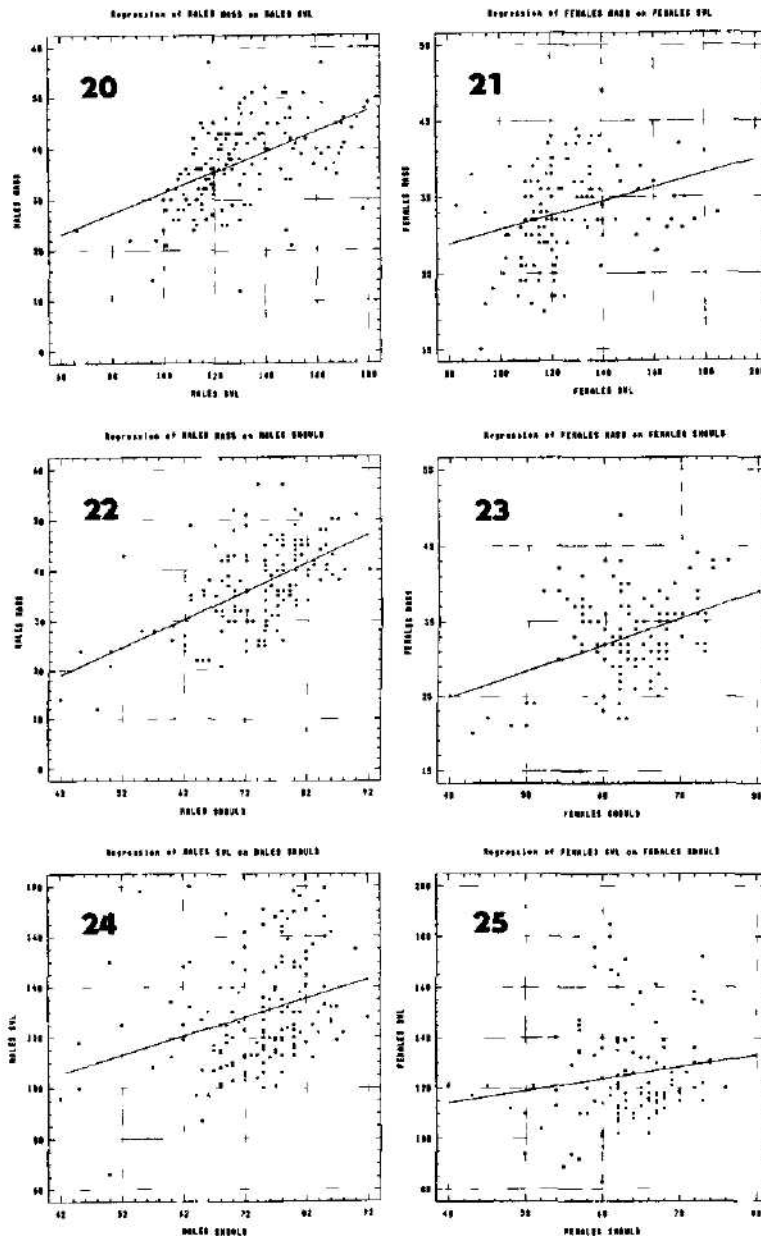
nile animals of both sexes represented 38.1% (n=117) and adult animals 61.9% (n=190) of all catches. Differences among years were not significant (Tab. 1).

Diet composition

Within the described period 109 wolves' stomachs were examined. Remains of red deer (*Cervus elaphus*) were found in 37 cases (34%), remains of roe deer (*Capreolus capreolus*) in 35 cases (32%) and remains of wild boar (*Sus scrofa*) in 28 cases (26%). Besides these main prey items, remains of mouflon (*Ovis musimon*) (2%), sheep (*Ovis domesticus*) (2%) and mouse-like rodent (1%) were also found. Remains of plant material were in three stomachs (3%) (Fig. 26).



Figs 16–19 Frequency histograms of ear length – males (16) and females (17), body weight – males (18) and females (19)



Figs 20–25. Regression of body weight on snout-vent length (males) (20) $Y = 11.0968 + 0.2018 X$ ($r = 0.5038$, $n = 165$, $P < 0.01$), regression of body weight on snout-vent length (females) (21) $Y = 21.6160 + 0.0914 X$ ($r = 0.3030$, $n = 132$, $P < 0.01$), regression of body weight on the height at shoulder (males) (22) $Y = 4.2550 + 0.5580 X$ ($r = 0.5913$, $n = 161$, $P < 0.001$), regression of body weight on the height at shoulder (females) (23) $Y = 7.9534 + 0.3523 X$ ($r = 0.3523$, $n = 129$, $P < 0.001$), regression of snout-vent length on the height at shoulder (males) (24) $Y = 74.0079 + 0.7496 X$ ($r = 0.3261$, $n = 162$, $P < 0.01$), regression of snout-vent length on the height at shoulder (females) (25) $Y = 91.7689 + 0.4680 X$ ($r = 0.1532$, $n = 129$, $P = 0.082$).

DISCUSSION

The area of distribution

The second half of the nineteenth century saw the end of continuous wolf settlement in Slovakian forests. The period of heavy hunting pressure led to complete extinction in Bohemia (around 1881) and Moravia (around 1914) (Feriancová-Masárová & Hanák 1965) and in Slovakia they were forced eastward. An increase of the slovakian population had been recorded after the first world war and this situation was repeated during the second world war. Up till the mid sixties wolves had lived in the Orava, Vysoké Tatry, Nízke Tatry, Polana, Levočské vrchy and Slovenské Rudohorie regions. In the Slánské vrchy Hills and Silická planina plain regions they reached their most southerly point. In the Nízke Beskydy and Vihorlat Hills the population density was traditionally highest. There were many cases of hunted wolves at the end of this period giving evidence about high stocks, but on the other hand they predict the following overhunting and retreat north-eastward. This process characterised the second half of the sixties and the first half of the seventies. Till the end of sixties wolves were in regions Polana, Silická planina plain, Orava, Nízke Tatry and around the upper Hron River extinct (Voskár 1976). Deterioration of the situation is also documented by the sharp decrease of young wolves in catches of hunters (Voskár 1976). A decreasing area of distribution and wolf population in 1972 was reported only from the Bardejov, Humenné, Poprad, Prešov, Svidník and Vranov regions (Hell 1974). This negative trend had been continuing till the mid seventies, when it was recognized as critical. During this time wolves inhabited only the Nízke Beskydy, Vihorlat and northern part of the Levočské vrchy hills mountain regions. Also in traditional refuges (Humenné, Svidník and Bardejov districts) the population density strongly decreased (Voskár 1975). In neighbouring countries, the trend

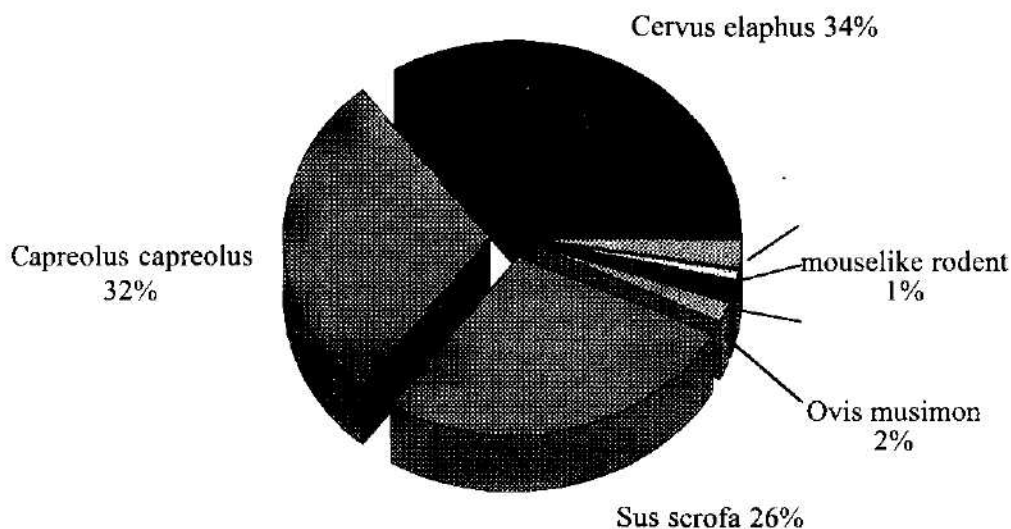


Fig. 26. The diet composition based on stomach analyses.

was the same and closely corresponded with the situation in Slovakia. At the continuing decrease in Poland, it has been estimated only 100 wolves living mostly in two refuges – Białowieża and south-eastern part of Poland, 200 in the Baltic countries, 450 in Ukraine and 800 in Belorussia. The latter region has been taken for the local centre of dispersion (Bibikov 1975). Also in these countries hunting pressure was responsible for the decrease of wolf population. Together with the fluctuation and availability of large ungulates and differences in local density of wolves, the hunting pressure is generally considered as the major factor controlling density of wolves (Packard & Mech 1980, Keith 1983). Under the influence of increasingly strict protection of this species the situation started getting better and since the start of the eighties (Hell & Ďurička 1991), which are mentioned in this paper, the wolves gradually returned to the regions from which they were formerly forced out. Directions of spreading were westward and south-westward and in the beginning of nineties they occupied a majority of the Slovakian mountain regions (Fig. 27). The increase of hunted wolves, culminating in the year 1989 (132 animals), corresponds well this situation. Whether this strong hunting pressure can predict outbalancing of pendulum of wolves population dynamics in Slovakia, the following years will show.

Biometrical data

Because the measurement of body sizes and weight was pursued directly by hunters, it is necessary to take into account lower accuracy and the possibility that some data can be overevaluated. These shortages are partly compensated by the large number of measurements. It is possible to compare some of this data to results which are obtained by Hell (1974) in the same manner in the period 1968–1972 on a slightly smaller sample of wolves. The mean weight of adult males (42.0 kg) and adult females (36.5 kg) found by him are very similar to values from this work (41.7 kg and 38.0 kg). In other values he states rather closer limits, which can be explained by limited sample analysed by him and also a greater chance of error during the gathering of metristics data by hunters. Also the bottom limit of maturity – 33 kg, can not be correct in all cases. However under the given conditions the similarity of both data files is evident. Considering that this is in both cases the same population, only measured at different times, this is not striking.

Frequency histograms of individual weight and metric categories show when the mortality of wolves caused by hunting starts to grow and also document normal distribution of individual categories giving evidence about the presence of all groups of animals in the population. They also support the usefulness of results based on hunted wolves to estimate the situation for the whole.

Composition of the population

How far the proportion of both sexes in killings represents the real situation in the population it is difficult to judge. Difference in living strategy of both sexes and consequently the different exposure of hunting pressure certainly distort the result. It is clear that in the described period 1984–1989 males dominated, but only marginally (58.9%) and the fluctuation of this value among years was not significant. Similar results from this population in period 1968–1972 obtained Hell (1974). The rate of sexes found by him was even closer (males 50.7% and females 49.3%).

The proportion of young individuals in population gives evidence about its vitality. Wolf packs with a higher proportion of young animals are able to tolerate rather higher mortality (Ballard et al. 1987) and stock can stay stable at killing 24% early winter population (Gasaway et al. 1983). Enhanced hunting of wolves in regions with higher population density results in the reduction of packs and consequently also territories, which will enable to found new wolf packs.

in free areas. Enhanced number of wolves shared with reproduction and consequently higher production of young animals is the result (Peterson et al. 1984). In the period of strong decrease of the Slovakian population, years 1968–1972, there were proportionally less of young wolves killed by hunters 32.2%, 23.5%, 70.0%?, 19.0%, 16.6% (Hell 1974). In the period described in this work (1984–1989) the young wolves constituted on average 38.1% and these data oscilated in individual years around this average (comp. with Hell & Ďurička 1991). Comparing with the period 1968–1972 these data give evidence about the continuation of a prosperous population. Results likely suffer from a mistake caused by different impact of hunting pressure on young and adult wolves, but they reflect the general trend adequately. The comparison of proportion of adult and young wolves within sexes in killings is interesting. While young females constituted on average 50%, young males only 29.8%. This inbalance can be explained by the higher mortality of males leaving the natal packs after reaching maturity.

Diet composition

Wolves in Slovakia traditionally caused serious damage to livestock and therefore they have been mercilessly persecuted. In spite of that wolves are very versatile in their feeding habits, the dependence on large ungulates is strong everywhere and the livestock is not an exception. The increase of intensification in agriculture after world war II caused a decrease in the availability of this type of food. Analyses of 33 wolves stomachs from period 1968–1972 support this claim (Hell 1974). Remains of roe deer have been found in 45%, red deer in 12%, wild boar in 6% and domestic sheep in 6%. Remains of cattle, hare and small rodent have been found each in 1%. Regardless of the possible confusion of red and roe deer remains it is evident that these ungu-

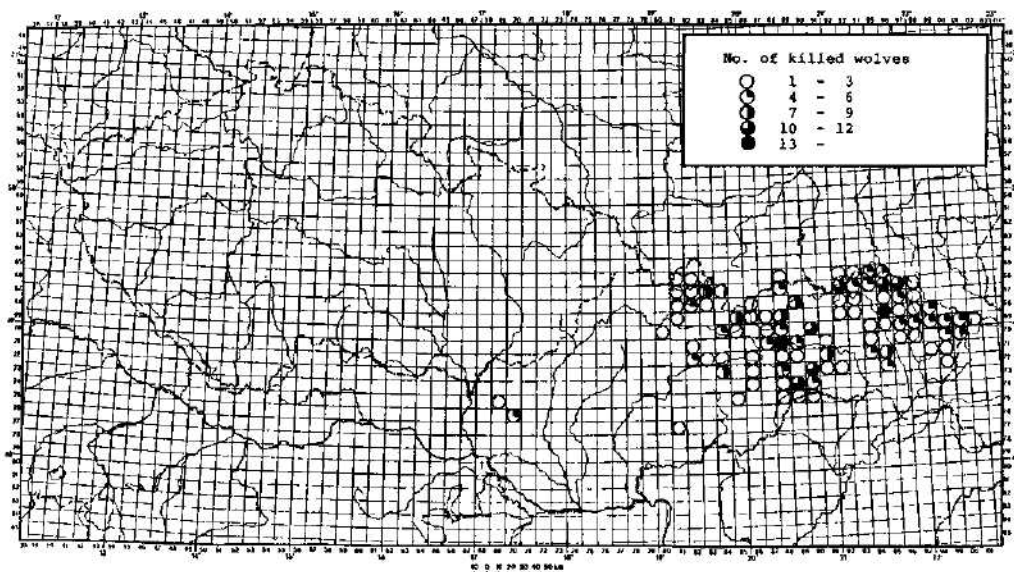


Fig. 27. The density of Slovakian wolf population based on the amount of killed animals during the period 1983–1990.

lates made up the dominant part of wolves diet. Data from this work are in accordance with the above mentioned findings and with findings of Hell & Ďurička (1991). Besides red and roe deer the wild boar composes also important prey item. Their mutual proportion will be different depending on the season and local conditions.

Clear dependence of wolf density on the biomass of ungulates has been found also in many other works (Mech 1977, 1986, Messier & Crete 1985, Peterson & Page 1988) and also surviving of young individuals strongly dependent on these animals (Mech 1977, Seal et al. 1975, van Ballenberghe & Mech 1975), whose species composition can differ locally. High stocks of red and roe deer also existing in the Slovakian region for the time being have a positive influence on the increase of wolf population.

Acknowledgements

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***Baloorthochirus becvari* gen. et sp. n. from Pakistan, and taxonomic position of *Orthochirus luteipes* (Scorpiones: Buthidae)**

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Abstract. *Baloorthochirus* gen. n. with the type species *B. becvari* sp. n. is described. The new genus is related to the following genera: *Birulatus* Vachon, 1974 from which it differs in the presence of keels on metasomal segments I–IV; *Butheolus* Simon, 1882 from which it differs in telson morphology and absence of trichobothrium d2 of the pedipalp femur on dorsal surface but its presence as internal trichobothrium; *Orthochirus* Karsch, 1891 and *Paraorthochirus* Lourenco et Vachon, 1995 from which it differs in the presence of granulation on 5th metasomal segment. *Orthochirus luteipes* Roewer, 1943 is here revised and its lectotype designated.

Taxonomy, descriptions, new genus, new species, faunistics, Scorpiones, Buthidae, *Baloorthochirus becvari* sp. n., *Orthochirus luteipes*, Pakistan, India

***Baloorthochirus* gen. n. (Figs 1–7, Table 1)**

TYPE SPECIES. *Baloorthochirus becvari* sp. n.

ETYMOLOGY. Masculinum; denotes affinity to the genus *Orthochirus* and the geographic distribution.

DESCRIPTION. A combination of characters differentiates this genus from all other genera of the family Buthidae. The basic trichobothrial pattern is beta (Fig. 3 and Sissom 1990: 70, fig. 3.3); legs III and IV have well developed tibial spurs; pectines with fulcra (Sissom 1990: 92, fig. 3.17D); dentate margin of pedipalp-chela movable finger with granules distinct, divided into rows, and spanning the length of the finger (Fig. 6); carapace, in lateral view, with a distinct downward slope from median eyes to anterior margin (Fig. 5 and Sissom 1990: 92, fig. 3.17F). This complex of characters is exhibited only by the genera *Birulatus* Vachon, 1974 from Jordan, *Butheolus* Simon, 1882 from Arabia, *Orthochirus* Karsch, 1891 from North Afrika and Arabia to India, and *Paraorthochirus* Lourenco & Vachon, 1995 from Iran. Differences from these genera are given in the key below. *Baloorthochirus* gen. n. is also characterized by the number and distribution of trichobothria on the pedipalps (Figs 3 and 6), 9 cutting edges on the movable fingers of pedipalps (Fig. 6), mesosoma with three inconspicuous keels, and other features included in the description of *Baloorthochirus becvari* sp. n. below.

AFFINITIES. *Baloorthochirus* gen. n. differs from just noted genera by features given in the key, which is integrated into the key of genera of the family Buthidae in Sissom (1990: 97):

Carapace, in lateral view, with a distinct downward slope from median eyes to anterior margin (Sissom 1990: 92, fig. 3.17F):

- Metasomal segments I–IV without keels *Birulatus*
 Metasomal segments I–IV with keels 1
 1. Metasomal segment V punctate 2
 – Metasomal segment V granulate (Figs 1 and 2) 3
 2. Trichobothrium d2 of pedipalp femur absent on dorsal surface but usually present as internal trichobothrium (Fig. 11) *Orthochirus*
 – Trichobothrium d2 of pedipalp femur present on dorsal surface (Lourenco & Vachon 1995: 302 fig. 10 and 303 fig. 16) *Paraorthochirus*
 3. Vesicle of telson narrow and smooth (Fig. 4). Trichobothrium d2 of pedipalp femur absent on dorsal surface but present as internal trichobothrium (Fig. 3) *Baloorthochirus* gen. n.
 – Vesicle of telson inflate, granulate, often with rudimental subaculear tubercle (Vachon 1980: 254 planche B). Trichobothrium d2 of pedipalp femur present on dorsal surface *Butheohis*

***Baloorthochirus becvari* sp. n. (Figs 1–7, Table 1)**

TYPE MATERIAL. Holotype – male preserved dry, labelled Pakistan, SE Balochistan, Khurkhra, 38 km S Uthal, 24 IV 1993, leg. Bečvář Stanislav. Deposited in the author's collection. Type material will be lately deposited in Department of Invertebrate Zoology, National Museum, Prague.

Tab. 1. Measurements in millimeters of *Orthochirus luteipes* and *Baloorthochirus becvari* gen. et sp. n. Line denoted „pectinal teeth“ contains numbers of both left and right teeth separated by a colon

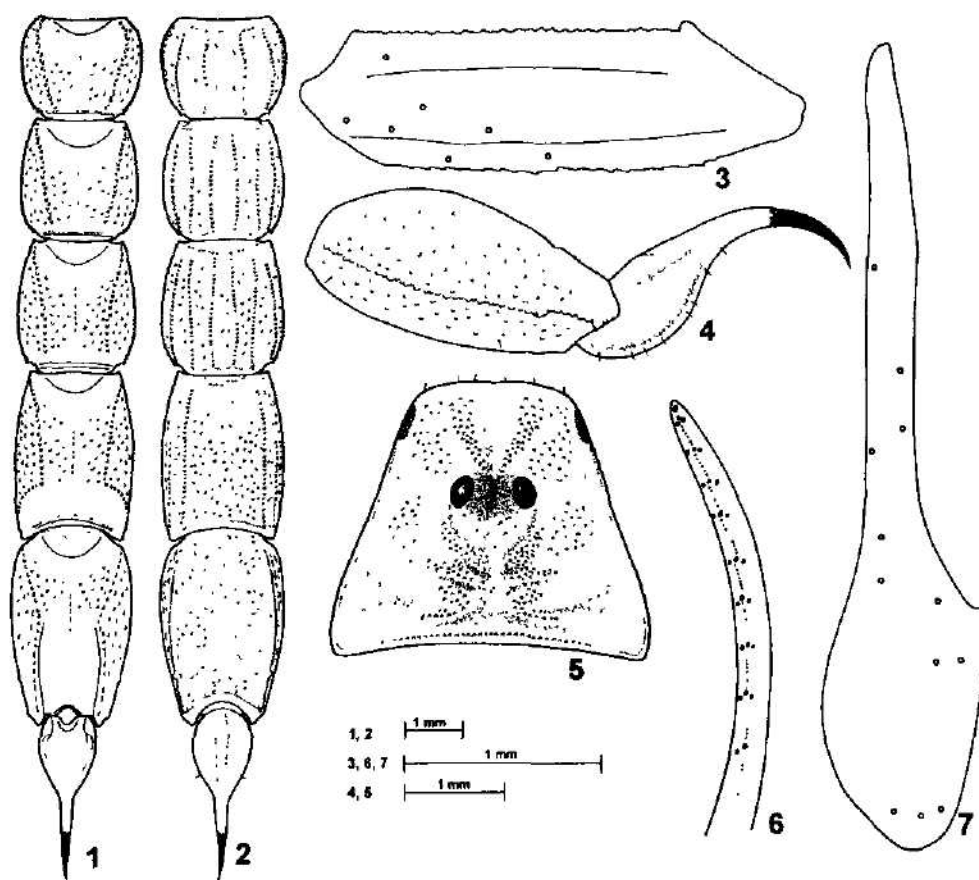
		<i>Orthochirus luteipes</i> lectotype male	<i>Orthochirus luteipes</i> paralectotype No. 1 female	<i>Baloorthochirus becvari</i> gen. n., sp. n., holotype
Total	length	29.6	34.5	23.4
Carapace	length	3.1	3.8	2.7
	width	3.6	4.6	3.4
Metasoma segment I	length	19.1	18.4	15.0
	length	2.1	2.2	1.7
	width	2.5	3.0	2.1
segment II	length	2.6	2.6	2.1
	width	2.3	3.1	2.0
segment III	length	2.8	2.8	2.3
	width	2.4	3.3	2.1
segment IV	length	3.4	3.6	2.9
	width	2.8	3.4	2.1
segment V	length	4.0	4.1	3.2
	width	3.3	3.5	2.2
telson	length	3.3	3.3	2.9
Pedipalp				
femur	length	2.7	2.1	2.5
	width	0.7	1.0	0.7
patella	length	3.2	3.3	2.7
	width	0.8	1.1	0.9
tibia	length	3.5	5.0	3.9
	width	0.9	1.0	0.6
finger m	length	2.1	3.3	2.6
Pectinal teeth		20:20	17:18	19:19

TYPE LOCALITY. Pakistan, SE Balochistan, Khurkhra, 38 km S Uthal. The specimen was collected at night in semidesert-type environment.

ETYMOLOGY. Named after the collector.

DESCRIPTION. The length is 23.4 mm. The metasoma is shown in Figs 1–2 and carapace in Fig. 5. Measurements of the carapace, telson, segments of the metasoma and of the pedipalps, and numbers of pectinal teeth are given in Table 1. There are 19 pectinal teeth. For the position and distribution of trichobothria on the pedipalps see Figs 3 and 7.

Color is yellow to yellowish-brown, with a dark spot on the posterior part of the carapace behind the median eyes. Inconspicuous dark spots are present also on the underside of metasomal segments IV and V. Mesosoma has one inconspicuous medial keel and two other keels which are even less developed and can be readily traced only on the mesosomal segment VI. Metasomal segments with keels (Figs 1 and 2). The dorsal surface of segments III through V has a medial groove. The surface of all metasomal segments is densely granulated all around. The



Figs 1–7 *Baloorthochirus becvani* gen. et sp. n. (holotype) Fig. 1. Metasoma dorsal, Fig. 2. Metasoma ventral, Fig. 3. Femur dorsal, Fig. 4. 5th metasomal segment and telson, Fig. 5. Carapace, Fig. 6. Movable finger of pedipalp, 7. Tibia external

telson is not granulated; it is smooth and shiny, and on the vesicle and the frontal (yellow) part of aculeus is covered by short, dense, light-colored hairs. The telson is very similar to that in the genus *Orthochirus*.

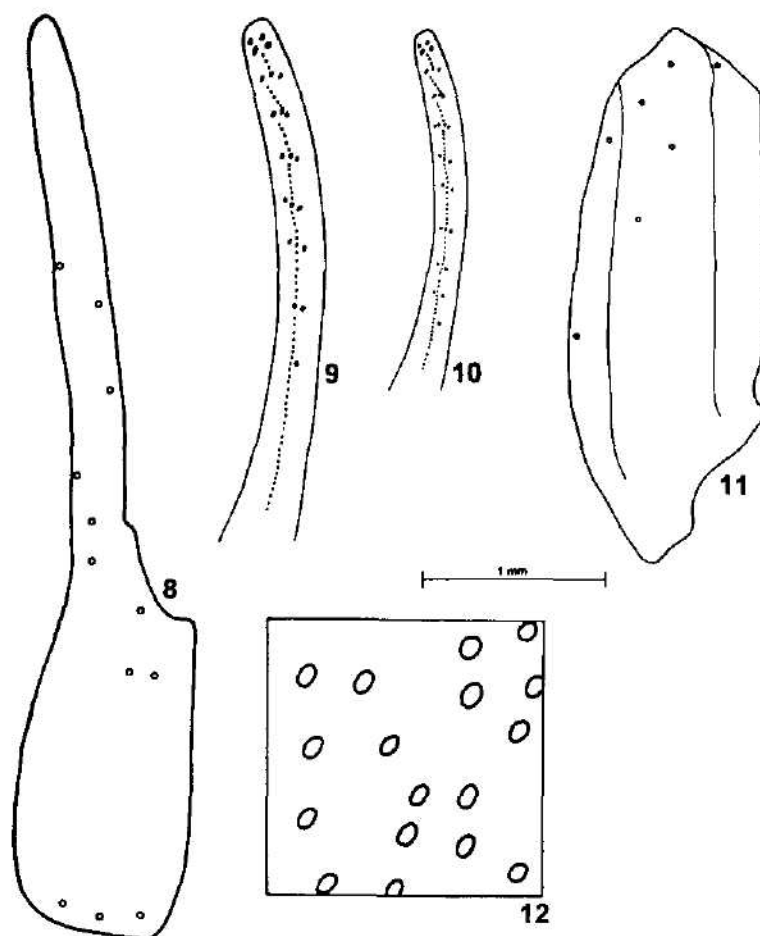
AFFINITIES. Differential diagnosis of the new species is included in the generic diagnosis.

***Orthochirus luteipes* Roewer, 1943 (Figs 8–12, Table 1)**

Orthochirus luteipes Roewer, 1943: 209.

Orthochirus fuscipes luteipes: Minnocci, 1974: 28.

MATERIAL. Lectotype (male) and paralectotype No. 1 (female) – by present designation – preserved in alcohol and labelled S. Dekan, Anamalei. The lectotype and paralectotype (coll. Roewer No. 2124, Scorpions No. 21) are deposited in the collection of Forschungsinstitut und Naturmuseum Senckenberg, Frankfurt am Main.



Figs 8–12. *Orthochirus luteipes*, Figs 8, 9 and 12, female (paralectotype), Figs 10–11, male (lectotype). Fig. 8. Tibia externa, Figs 9. and 10. Movable fingers of pedipalp, Fig. 11. Femur dorsal, Fig. 12. 5th metasomal segment dorsal.

TYPE LOCALITY. Anamalei, South Dekan, India.

COMMENTS. The length is 29.6 mm in the lectotype (male) and 34.5 mm in the paralectotype No. 1 (female). Measurements of the carapace, telson, segments of the metasoma and segments of the pedipalps, and numbers of pectinal teeth are given in Table 1. There are 20 pectinal teeth in the male and 17–18 pectinal teeth in the female. For the position and distribution of trichobothria on the pedipalps see Figs 8 and 11.

Movable fingers have different numbers of internal and external granules in the lectotype (Fig. 10) and paralectotype (Fig. 9).

Mesosoma has three medial keels, which in the male are apparent only on the last three segments. Taxonomic position. Roewer (1943: 209) based the species on 3 males and 2 females, without designating a holotype. I have been able to examine two of the type specimens and have designated them the lectotype (male) and paralectotype No. 1 (female). The lectotype was examined in 1977 by Vachon, who numbered it VA 2182.

Orthochirus luteipes is not mentioned in recent literature. It is not included in Tikader & Bastawade's monograph *Scorpions of India* (Tikader & Bastawade 1983), although pages 113 through 140 cover the genus.

Orthochirus in India and include a description of the new species *Orthochirus krishnai* Tikader et Bastawade, 1983.

DISCUSSION. I believe *Orthochirus luteipes* Roewer, 1943 to be a valid species, but consider a revision of the entire genus necessary for a final decision because currently some species are inadequately characterized.

Taxonomy of *Orthochirus* is difficult due to the amount of variation within species and even within individual populations, which includes characters ordinarily used to delimit genera, e. g. the number of cutting edges and external and internal granules of movable fingers of pedipalps (Figs. 9 and 10), and the number of keels on mesosomal segments. Study of 40 specimens belonging to at least two species from Afghanistan (Kovářik 1993) convinces me that also coloration contributes to the intraspecific variability in *Orthochirus*.

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BOOK REVIEW

WHELANXR W *The Ecology of Fire* Cambridge: Cambridge University Press, 1995, x+346 pp Price not stated

I shall first let the author speak for himself about the central questions raised in his monograph "Wildfires kill many animals but are populations of animals affected? How do animals survive the passage of fire? Do frequent fire cause changes in plant community composition? Why do some tree species survive and other die in a fire? How important is long-distance seed dispersal in vegetation recovery after fire? How does fire affect plant-herbivore interactions and predator-prey interactions? What are the effects of frequently applied, out of season fires for land management?"

Many more such basic problems are covered in eight richly illustrated, clearly written chapters, each outlining not only the present knowledge, but equally stressing the outstanding questions

The phenomenon of wildfire is usually seen as something marginal, ad hoc locally catastrophic, and generally of little significance. Quite different are the views of ecology students working in those parts of the world where extensive fires occur regularly and with stochastic periodicity. They appreciate the selective force of this phenomenon, as well as the problem of explaining adaptive survival strategies and reproductive adjustments of individuals, species (particularly those of woody plants) and ecosystems to the fire.

The author treats the subject comprehensively, lucidly, and from view of short-term effects and adaptations. He refrains from treating it speculatively on a geological time scale, feeling that we do not have a sufficient amount of accurate data on short-term effects and strategies. To me this attitude seems a little unfortunate, since I believe a proximate explanation must be linked with a historical perspective. It should take into account also the extensive fires occurring during major biotic catastrophes, and providing probably background for major adaptations as well as for fire affected speciations. However, everybody interested in the effects of fire on plants, animals and ecosystems as seen in ecological time perspective will find here only a large number data, hypotheses and questions concerning this phenomenon, but also an appealing incentive for its further study. The reader may be surprised to learn that the present monograph is of 19 on ecological fire effects which have been published since 1982.

The book is warmly recommended to everybody interested in the only seeming "exotic" phenomenon of extensive wildfires. The reader will learn, at least, these fires result not only in mass deaths of individual organisms, but also provide new life opportunities, and are necessary for the survival and reproduction of many species and ecosystems.

Pavel Štys

***Anisoplia hebrothracica* sp. n. from Bulgaria (Coleoptera: Scarabaeidae)**

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Abstract *Anisoplia hebrothracica* sp. n. is described from Bulgaria, assigned to the *A. deserticola* Fischer von Waldheim, 1824 species-group, and included in a revised key to this species-group. The new species differs from closely related species *A. thessalica* Reitter, 1889 and *A. tenebralis* Burmeister, 1844 by different shape of pronotum, extremely shortened extemobasal elytral protuberance in female, and subapically angulate dorsolateral margin of paramere.

Taxonomy, new species, key, Scarabaeidae, Rutelinae, *Anisoplia*, Palaearctic region

The genus *Anisoplia* Dejean, 1821 contains according to the Baraud's (1991) revision over 50 species all confined to the Palaearctic region with the greatest species diversity in eastern Mediterranean. *A. deserticola* Fischer von Waldheim, 1824 species-group established by Baraud (1991), and belonging to the nominotypical subgenus, has comprised the following four so far known species: *A. deserticola* inhabiting the Balkan peninsula (Bulgaria, Greece, Roumania, Serbia), Moldavia, Ukraine, and southernmost regions of the European part of Russia eastward to the Aral Lake region and to Azerbaydzhan (records from „Hungary“ concern the Banat region, now in Roumania), *A. imitatrix* Apfelbeck, 1909 known from Greece (Thessalia) and Macedonia, *A. tenebralis* Burmeister, 1844 distributed in western and southern parts of Turkey eastward to the Hatay province, and *A. thessalica* Reitter, 1889 known from Bulgaria, European Turkey, Greece and Macedonia (Baraud 1991, Medvedev 1949, Mikšić 1953, Panin 1955, Zakharieva-Stoilova 1962).

Obviously distinct new species discovered in Bulgaria (Thracian lowlands) and belonging to this species-group is described in the present paper.

Specimens of the newly described species are provided with one red label *Anisoplia hebrothracica* sp. n., HOLOTYPUS, resp. ALLOTYPUS, or PARATYPUS, David Král det. [printed] 1990 [handwritten]. Exact label data are cited for the type material. Author's remarks and complementations are found in square brackets; [p] – preceding data are printed.

***Anisoplia hebrothracica* sp. n.**
(Figs 1, 2, 4, 6, 7)

TYPE MATERIAL. Holotype (male), allotype (female with damaged pro- and metatarsi) and 1 paratype (male), labelled Bulg. 24/6–1/7 [19]74, Harmanlı, J. + D. Král lgt. [p], coll. D. Král; 1 paratype (male), labelled Bulgaria 30 V [19]82, Charmanlı, J. Hladil lgt. [p], coll. D. Král; 28 paratypes (27 males, 1 female), labelled: SE Bulgaria, Harmanlı (Marica riv.), 29–30 VI.1982, Vít. Kubáň leg. [p], 4 males and 1 female coll. D. Král, 2 males in coll. S. Bílý (Praha), 1 male in Hungarian National Museum, Budapest (coll. L. Ádám), 10 males in coll. V. Jiříček (Prostějov, CZ), 1 male in coll. V. Malý (Praha), 1 male in coll. M. Nikodým (Praha) and 8 males in coll. P. Pacholátko (Brno).

DESCRIPTION. Body relatively slender with long legs; black with bluish or greenish shade of colour, almost opaque; tibia, tarsus and antenna except of club dark brown; elytron light yellowish brown, opaque. Setation of dorsal and ventral surface pale or white.

Male. Body length: 9.5–10.8 mm.

Head. Clypeus narrow, with sides of posterior part basally (at level of insertion of antennae) slightly emarginate, then converging to anterior part forming recurved rostrum, anterior margin broadly rounded. Frontoclypeal suture distinct. Punctuation consisting from large, superficial, densely spaced, sometimes confluent punctures. Punctures of clypeus and frons bearing relatively long, almost erect setae.

Pronotum with markedly projecting anterior angles. Sides distinctly diverging posteriad in approximately anterior third, then almost parallel to approximately rectangular posterior angles (Fig. 1). Basal margin bisinuate. Margins all around bordered. Punctuation rather finer than in head, consisting from large superficial, densely spaced punctures. All dorsal surface clothed with short recumbent setae.

Scutellum short, triangulate, with distinctly confluent punctuation and shortly recumbently setaceous.

Elytron with distinct shoulder, side regularly rounded. Membranous margin developed only in apical part (reaching approximately to level of basis of propygidium). Striae subobsolete, intervals almost flat. Punctuation consisting from fine, sparse and irregularly spaced punctures, bearing very short semierect setae except upon scutellar area clothed with rather dense short recumbent setae (same as in scutellum). Externobasal margin without row of spinlike setae, only basally with group of short strong setae.

Internal protarsal claw relatively slender, cleft at middle, subapically with small dens, apically acuminate (Fig. 4). **External protarsal claw** cleft, **external metatarsal claw** simply acute. Sternites and propygidium clothed with very dense, short, recumbent setae. Pygidium covered with very short recumbent setae becoming gradually denser apically.

Paramere in dorsal view with dorsolateral margin in about apical half distinctly divergent and remarkably angulate subapically (Fig. 7); in lateral view relatively narrow, regularly curved and acute apically (Fig. 6).

Female differs from the male in the following characters: pronotal sides distinctly diverging posteriad in anterior third, then only slightly subparallel and slightly broadly emarginate to posterior angles (Fig. 2); elytron with very slightly expressed externobasal protuberance reaching only to level of sternite 1; elytral striae distinctly expressed, intervals slightly convex; tibia and tarsus more slender, internal protarsal claw simple.

COLOUR VARIABILITY. Elytra in allotype with slightly expressed dark brown to blackish lateral margins including externobasal protuberance, humeral calus, and very slightly indicated cross-like pattern.

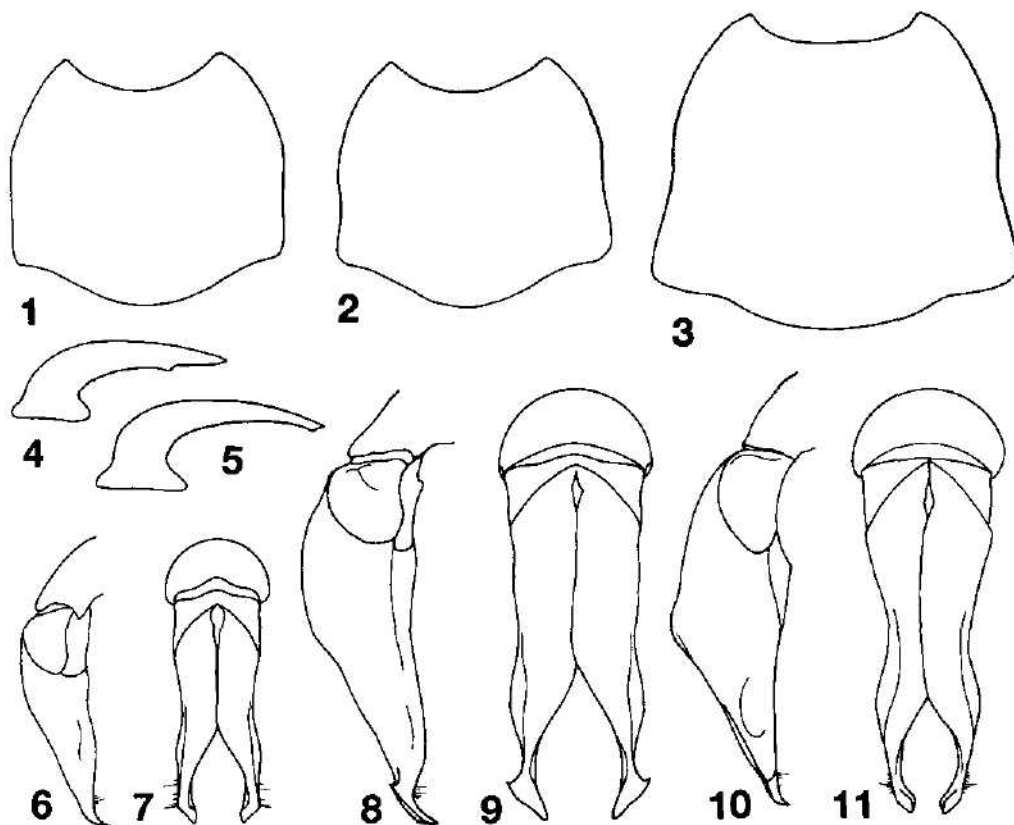
DIFFERENTIAL DIAGNOSIS. *A. hebrothracica* sp. n. is placed to the *A. deserticola* species-group (sensu Baraud 1991) characterized by the following complex of diagnostic characters: external membranous elytral margin developed only in apical part; externobasal elytral margin without row of short spinlike setae; setation of sternites, propygidium, and pygidium consisting from short, recumbent setae; internal protarsal claw in male not simply acuminate; and parameres in lateral view not flattened and not S-shaped. For the differential diagnosis within the *A. deserticola* species-group see the key below.

COLLECTION CIRCUMSTANCES. Specimens collected by the author and by V. Kubán were taken from various species of grasses on sandy island of the Maritsa river near the camping site south of Harmanli.

ETYMOLOGY. The specific name is derived from Hebrus, Latin name of the Maritsa river, and Thracia.

Key to the *Anisoplia deserticola* species-group

- 1 (4) Internal protarsal claw in male shortly, obliquely cut off apically (Fig. 5).
 2 (3) Protarsites approximately wide as long, not distinctly wider than meso- and metatarsites. Basal half of pronotal sides divergent posteriad and slightly sinuate. Dense clytral setation restricted to whole basal area. Bulgaria, Greece, Moldavia, Roumania, Serbia, Ukraine, southernmost regions of European part of Russia, eastward to the Aral Lake region and to Azerbaydzhan. *A. deserticola* Fischer von Waldheim
 3 (2) Protarsites markedly wider than long and distinctly wider than meso- and metatarsites. Basal half of pronotal sides approximately parallel and straight. Dense clytral setation restricted only to scutellar area. Greece, Macedonia. *A. imitatrix* Apfelbeck



Figs 1-11 1-3 - shape of pronotum, dorsal view; 4-5 - left internal protarsal claw of male, lateral view; 6, 8, 10 - right paramere, lateral view; 7, 9, 11 - parameres, dorsal view. 1, 4, 6-7 - *Anisoplia hebrothracica* sp. n., holotype; 2 - the same allotype (female), 3, 8-9 - *A. thessalica* (SW Bulgaria, Sandanski); 5 - *A. deserticola* Fischer von Waldheim (W Kazakhstan, Chelkar), 10-11 - *A. tenebralis* Burmeister (Asia Minor).

- 4 (1) Internal protarsal claw in male apically acuminate and subapically with small dens (Fig. 4)
- 5 (6) Basal two thirds of pronotal sides almost parallel and straight in male or only slightly divergent posteriorly and slightly, broadly sinuate in female (Figs 1, 2). Externobasal elytral protuberance in female very short, reaching only to level of sternite 1. Paramere with dorsolateral margin angulate subapically (Figs 6, 7). Relatively smaller species with body length 9.5–10.8 mm. Bulgaria (Thracian lowlands) *A. hebrothracica* sp. n.
- 6 (5) Basal two thirds of pronotal sides distinctly divergent posteriorly and broadly sinuate in both sexes (Fig. 3). Externobasal elytral protuberance in female longer, reaching to level at least of basis of sternite 2. Dorsolateral margin of paramere of another shape (Figs 8–11). Relatively larger species with body length 10.5–14.5 mm.
- 7 (8) Dorsolateral margins of paramere with distinct dens (Figs 8, 9). Bulgaria, European Turkey, Greece, Macedonia *A. thessalica* Reitter
- 8 (7) Dorsolateral margins of paramere broadly rounded (Figs 10, 11). Western and southern parts of Turkey, doubtful, not confirmed records from „Graccia“. *A. tenebrahs* Burmeister

Acknowledgements

I wish to thank my wife Regina for finishing the line drawings.

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Early and middle Pleistocene birds from the Bohemian Karst, Czech Republic

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Abstract. One early Biharian, two late Biharian, and one middle Pleistocene localities from the Bohemian Karst yielded remains of 11 bird species, incl. two extinct (*Palaeocryptonyx donnezani* Depéret, 1897 and *Strix intermedia* Jánossy, 1972)

Aves, Biharian, middle Pleistocene, Czech Republic

INTRODUCTION

Early Pleistocene (Biharian) deposits in the Bohemian Karst yielded numerous remains of small vertebrates (Horáček 1979, 1980, 1982, 1984, Horáček & Ložek 1988). Birds are relatively scarce, but form a welcome addition to our knowledge of the Biharian avifaunas of Europe.

Bohemian Karst (Český kras) is located SW of Praha in Central Bohemia, Czech Republic. Birds were excavated from four localities. The oldest of them, Chlum 6, is early Biharian in age, i. e. it belongs in the biozone Q₁ sensu Horáček & Ložek (1988). Červený lom 2 and C-718 (the latter being also known as Koněprusy or Konieprusy) are late Biharian in age, belonging in the biozone Q₂ sensu Horáček & Ložek (1988). More exact age is unknown for Červený lom 2, but the locality C-718 belongs in the youngest Biharian, Q-zone 2₃ (Horáček & Ložek 1988), which corresponds to the glacial cycle H sensu Kukla (1975, 1978). Chlum 4C belongs in the earliest middle Pleistocene, Q-zone 3₁ (Horáček & Ložek 1988), which corresponds to the glacial cycle G sensu Kukla (1975, 1978).

The sequence of Recent species follows Voous (1977). Minimum numbers of individuals were calculated according to Grayson (1984). Stratigraphy follows Horáček & Ložek (1988).

The material has been forwarded to me by Oldřich Fejfar and Ivan Horáček (Praha). I thank them both very much. The material is currently deposited in the author's collection.

SYSTEMATIC LIST

Anatidae

Anas clypeata Linnaeus, 1758

MATERIAL. Chlum 4C: distal radius dex.; MNI = 1.

REMARKS. This species is abundant in similarly old deposits of Stránská skála in Brno (Mlíkovský 1995).

Accipitridae

Aquila cf. chrysaetos (Linnaeus, 1758)

MATERIAL. Chlum 4C: eggshell fragments; MNI = 1.

REMARKS. Accipitrid birds have extremely thick-shelled eggs. Within the family, thickness of eggshell fragments (ca. 0.6 mm) fits the data for *Aquila chrysaetos* only (Schönwetter 1960–1967).

Phasianidae

Tetrao tetrix Linnaeus, 1758

MATERIAL. Chlum 6: premaxilla, dist. ulna dex., 2 dist. tibiotarsi (1 sin., 1 dex.); MNI = 1.

Palaeocryptonyx donnezani Depéret, 1897

MATERIAL. Chlum 6: prox. coracoid sin.; MNI = 1. C-718: prox. sternum, prox. scapula, humerus dex., prox. humerus sin., dist. humerus sin., ulna sin., ulna dex., carpometacarpus dex., 2 dist. tibiotarsi sin., dist. tarsometatarsus dex.; MNI = 2.

MEASUREMENTS. Humerus: greatest length = 43.1 mm, proximal width = 11.9 mm, distal width = 8.8 mm; ulna: distal width = 6.0, 6.4 mm; carpometacarpus: greatest length = 24.0 mm, proximal width = 6.9 mm; tarsometatarsus: distal width = 7.7 mm.

REMARKS. This extinct species was widespread in southern and central Europe since the early Pliocene till the end of the Biharian (Mlíkovský, unpubl.).

Coturnix coturnix (Linnaeus, 1758)

MATERIAL. C-718: dist. humerus dex., ulna sin.; MNI = 1.

Strigidae

Strix intermedia Jánossy, 1972

MATERIAL. C-718: tarsometatarsus dex.; MNI = 1.

MEASUREMENTS. Greatest length = 50.2 mm, proximal width = 11.1 mm, distal width = 12.6 mm.

REMARKS. This extinct species was described from the earliest middle Pleistocene (Q 3₁) of Tarkő in Hungary (Jánossy 1972, see also Jánossy 1977, 1986), and recorded also from the similarly aged locality Saint-Estève-Janson in France (Mourer-Chauviré 1975a, b). The alleged records from the late Biharian (Q 2) of Stránská skála in the Czech Republic (Jánossy 1972), and the earliest middle Pleistocene (Q 3₁) of Hundsheim in Austria (Jánossy 1974) are invalid (Mlíkovský, unpub. observations). Valid record of *Strix intermedia* is thus limited to the glacial cycles H–G, i. e. biozones Q 2₃–3₁ of France, Czech Republic and Hungary so far.

Picidae

Dendrocopos major (Linnaeus, 1758)

MATERIAL. C-718: prox. humerus sin.; MNI = 1.

Hirundinidae

Hirundo rustica Linnaeus, 1758

MATERIAL. C-718: 2 prox. humeri (1 sin., 1 dex.); MNI = 1.

Turdidae

Turdus sp.

MATERIAL. C-718: 3 prox. humeri (2 sin., 1 dex.); MNI = 2.

Tab. 1. Early Pleistocene birds from the Bohemian Karst. Červený kopce 2 yielded only bone fragments of small indeterminate passerines, and is not included here. Figures mean number of bones/MNI

	Chlum 6	C-718	Chlum 4C
<i>Anas clypeata</i>	—	—	1/1
<i>Aquila</i> cf. <i>chrysaetos</i>	—	—	—/1
<i>Tetrao tetrix</i>	4/1	—	—
<i>Palaeocryptonyx donnezani</i>	1/1	11/2	—
<i>Coturnix coturnix</i>	—	2/1	—
<i>Strix intermedia</i>	—	1/1	—
<i>Dendrocopos major</i>	—	1/1	—
<i>Hirundo rustica</i>	—	2/1	—
<i>Turdus</i> sp.	—	3/2	—
<i>Garrulus glandarius</i>	—	1/1	—
<i>Pyrrhocorax graculus</i>	—	1/1	—
11 species	5/2	22/10	1/2

REMARKS. These humeri fall in the class of medium-sized European *Turdus* thrushes (*Turdus merula* Linnaeus, 1758 and *Turdus philomelos* Brehm, 1831). Their closer identification is impossible.

Corvidae

Garrulus glandarius (Linnaeus, 1758)

MATERIAL. C-718: prox. femur dex.; MNI = 1.

Pyrrhocorax graculus (Linnaeus, 1766)

MATERIAL. C-718: prox. carpometacarpus sin.; MNI = 1.

DISCUSSION

TAPHONOMY. Most of the avian species were brought to the karst fissures by some predator(s). Eagle *Aquila* cf. *chrysaetos* was recorded as breeding in Chlum 4C, and the single shoveler *Anas clypeata* found there could well be its prey. On the other hand, extinct owl *Strix intermedia* was found in C-718. Diversity of smaller avian species recorded in C-718 indicates that it could be responsible for a larger part of the local avian taphocenosis. However, barn swallows *Hirundo rustica* could breed at the site.

ECOLOGY. Avian species recorded from the Biharian deposits in the Bohemian Karst are less suitable for paleoecological reconstructions.

BIOGEOGRAPHY. A quail (*Palaeocryptonyx donnezani*) and an owl (*Strix intermedia*) became extinct. All other species found in Biharian fissures of the Bohemian Karst still inhabit Central Europe.

PALEOPATHOLOGY. None of the bones reported above showed any pathological changes.

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A laboratory study of the efficiency and attractiveness of pitfall traps for *Pardosa agrestis* (Aranea)

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Abstract Efficiency (frequency of captures) and the mode of action of pitfall traps were studied for males, females and juveniles of *Pardosa agrestis* (Westring, 1861) under laboratory conditions. The experiment was designed to find out why formaldehyde pitfall traps (without detergent) capture fewer females and juveniles than males, even though all are equally abundant. Formaldehyde and water trapping fluids, and the effect of humidity on trapping success were tested. Formaldehyde showed significant repellent properties for adults as well as for juveniles. Females and juveniles were captured more frequently than males as a result of their hiding behaviour. The very reason of capture inequality is attributed to different survival and escape abilities of both sexes and juveniles. It was observed that males were killed by 4% formaldehyde in one hour, whilst females took 2 hours and juveniles 6 hours. The lowest effective 10% concentration of formaldehyde kills all spiders within one hour, thus limiting the probability of escape.

Pitfall traps, capture efficiency, humidity, trapping fluid, time to death, spiders, *Pardosa agrestis*

INTRODUCTION

Since the first introduction of the pitfall trapping method to entomologists (Barber 1931), pitfall traps have become certainly the most frequent method for spider collecting. For more than 50 years they were used to describe population processes: phenology, abundance, diurnal activity (Topping & Sunderland 1992, Alderweireldt 1989), including side-effects of pesticides (Dinter & Poehling 1992). However, they have been frequently criticized (e. g. errors reviewed by Adis 1979).

Consequently, a list of factors influencing trapping success has been described (e. g. Dinter & Poehling 1992, Müller 1984, Akkheruis 1993, Honěk 1988, Spence & Niemela 1994, Topping 1993). Most studies were done in the field, and thus usually describe the simultaneous effect of several factors. Only recently have some authors investigated the nature of trapping under laboratory conditions (Topping 1993, Halsall & Wratten 1988), or in the field (Topping & Luff 1995). It has become apparent that individual behaviour of the species being trapped can have a considerable effect on trappability (Sunderland et al. 1995).

The aim of this study was to reveal factors responsible for different trappability of males, females and juveniles into formaldehyde traps without detergent, and thus to answer question 'why the capture proportion of females and juveniles, in particular, is overrated by males, even though all are equally abundant.'

MATERIAL AND METHODS

1. Trapping success experiment

Sixty specimens (20 juveniles, 20 males and 20 females) of *Pardosa agrestis* (Westring, 1861) were collected in a field and immediately examined. Spiders were placed separately into transparent plastic boxes of 10×12.5×6 cm size covered with a nylon fabric. The boxes were filled to a depth of 1 cm with a soil substrate. A small plastic bottle (50 ml, neck diameter = 25 mm) = a pitfall trap, was inserted into a hole made in the middle of the bottom so that the neck was level with the substrate surface. The neck was wide enough and could not be avoided even by adult spiders. The bottle was filled with water, or 4 % formaldehyde to 1/3 of its volume. The original idea was to find out whether the formaldehyde has different attractiveness for males, females and juveniles of spiders. To this end the boxes were designed. A pitfall trap was placed into the center of a box because most spider activity is spent by walking along sides. So it could not fall into the trap if not attracted.

Spiders were maintained at room temperature of 19 °C. For the first 3 days the boxes were sprayed with water in the morning and in the evening. For another three days the boxes were left to dry to follow the effect of desiccation on capture. The relative humidity was measured in the morning (by means of THERM 2246-2) on 3 levels: in the box, in the trap neck, and in the trap (Fig. 1). The spiders were not fed during 6 days of the experiment.

Number of captures were counted by watching (controlling) boxes at hourly intervals, from 7 a.m. to 9 p.m. It was sufficient, except for some males that were killed within one hour. Captured spiders were released and the experiment continued. No observation was made during night time. According to my previous experiments spiders did not fall into a trap at night.

The data (Table 1) were analyzed by 3-way ANOVA (repeated measures) using two response variables: time to the first capture and the frequency of captures. The effect of following 3 factors was tested.

1. trapping fluid (water vs. formaldehyde)

2. sex (males, females, juveniles)

3. humidity (moist vs. dry)

Time to the first capture and the frequency of captures of individuals that persisted inside a trap as well as those that have not been captured at all were not analyzed (because such set of data did not match the normal distribution).

2. Survival experiment

After the trapping success experiment the spiders were used to find out their time to death of 4%, and 40% formaldehyde by putting them on the surface of the solution in a 100 ml can. In addition 10% and 20% solutions were tested for females and juveniles.

RESULTS

1. Analysis of trapping success

A. Time to the first capture

The idea of the first capture was based on the assumption that formaldehyde trapping fluid has a different attractiveness for males, females and juveniles. The shorter the time of the first capture, the more attractive the trapping fluid is. Moreover, the first capture is not affected by previous experience.

Of the three factors, only humidity [$F(1;33)=13.06$; $p<0.001$] and the two-way interaction humidity × fluid [$F(1; 33)=6.04$; $p<0.019$] had highly significant effect. Under moist conditions time to the first capture was shorter (11.41 hrs) for all sex groups than when the surface run dry (20.34 hrs). While in moist conditions the times to the first capture were similar for water and for formaldehyde fluids (12 hrs vs. 10.83 hrs), in dry conditions the time for formaldehyde fluid become almost twice longer (25.83 hrs vs. 14.85 hrs). Contrast analysis did not confirm expected difference in time to the first capture for sex groups.

B. Frequency of captures

The frequency of captures is influenced by various factors over a period of time. Thus, unlike the first capture, the total frequency of captures might be affected by previous experience which may be a consequence of avoidance /or attraction.

Tab 1 Time to the first capture / frequency of captures. „–“ indicates individuals persisted inside a trap „**“ indicates mortality, i. e. individuals killed by formaldehyde during the experiment. „Ø“ indicates individuals that avoided a trap

	No	water		formaldehyde	
		moist	dry	moist	dry
males	1.	13/3	35/2	10/3	31/2
	2.	12/2	25/4	1/3	8/3
	3.	25/2	9/3	2/2	10/1*
	4.	Ø	Ø	29/1*	
	5.	Ø	51/1	26/1*	
	6.	11/1–	–	50/1	11/2
	7.	8/3	5/2	7/2	26/2
	8.	11/3	8/4	5/4	14/1*
	9.	25/4	4/5	13/3	28/2
	10.	1/3	25/2	7/4*	
females	1.	7/3	8/3	3/3	20/3
	2.	13/5	6/5	2/1	38/2
	3.	6/1–	–	Ø	13/2
	4.	2/8	25/3	2/1–	–
	5.	1/1–	–	7/2	30/2
	6.	5/5	5/6	10/4	12/4
	7.	8/5	13/4	26/2	5/3
	8.	10/4	26/3	5/2	10/3
	9.	3/1–	–	35/2	51/1
	10.	7/3	12/4	7/1–	–
juveniles	1.	12/3	5/4	2/4	29/4
	2.	9/1–	–	Ø	3/2
	3.	5/2	10/3	5/2	35/2
	4.	5/4	4/5	7/4	28/3
	5.	60/1	Ø	12/1–	–
	6.	12/6	2/4	3/1–	–
	7.	Ø	30/2	30/2	50/1
	8.	11/4	27/3	Ø	Ø
	9.	3/1–	–	Ø	Ø
	10.	9/4	28/4	2/2	28/2

Formaldehyde trapping fluid showed significant repellent properties [$F(1;39)=8.54$; $p<0.005$] for both sexes and juveniles; on average by 1.14 capture less than for water fluid. Contrast analysis revealed significant difference [$F(1;39)=5.26$, $p<0.03$] between capture means of both sexes and juveniles for both trapping fluids only under moist conditions (Table 2). Juveniles were captured more frequently than males, and females even more frequently into water traps, whereas into formaldehyde traps the frequency was almost identical.

2. Time to death

The times to death/or exact mortality rates are displayed in Table 3. Males were killed by 4% formaldehyde in an hour, females within 2 hours and juveniles within 6 hours. The survival ratio looks as follow: 1:2:6. In 40% solution the difference in times to death was negligible. Similarly, both intermediate concentrations (10 and 20%) killed females and juveniles within

Tab. 2. Mean frequency of captures of all sex groups for both trapping fluids in moist conditions

Sex \ Fluid type	water	formaldehyde
males	2.38	2.40
females	4.35	2.25
juveniles	3.06	1.75

less than 1 hour. Nevertheless, the 10% concentration is probably the lowest effective concentration of approximately equal killing effect on both sexes and juveniles (Fig. 3).

3. Comment on behaviour

Observing spiders approaching a trap, I have established that the spiders do not fall into the trap suddenly by accident. The spiders are careful, investigate the area and do not enter the trap at every encounter. If a spider decides to enter, it descends into a trap on a drag-line and can go back unless the length of the silk thread exceeds twice the length of its body, approximately. Such behavior not resulting in capture, was recorded many times. However, not all trapped spiders are finally captured. Formaldehyde solutions have a strong surface tension that allows spiders to walk/crawl upon them. If the spider happens to crawl to the trap wall, it could be saved by spinning a web upon the wall and escaping by this means.

It has been observed that several individuals spun a web on the wall of the trap and spent all the time inside the trap, or escaped and re-entered the trap whenever wanted. One male (5%), 5 females (25%) and 4 juveniles (20%) exhibited such hiding behavior (Table 1). By contrast, some individuals did not enter/ fall into the trap during 6 days. Some individuals used the trap as a shelter. When disturbed, e. g. by the spraying of water, they ran and jumped into the trap.

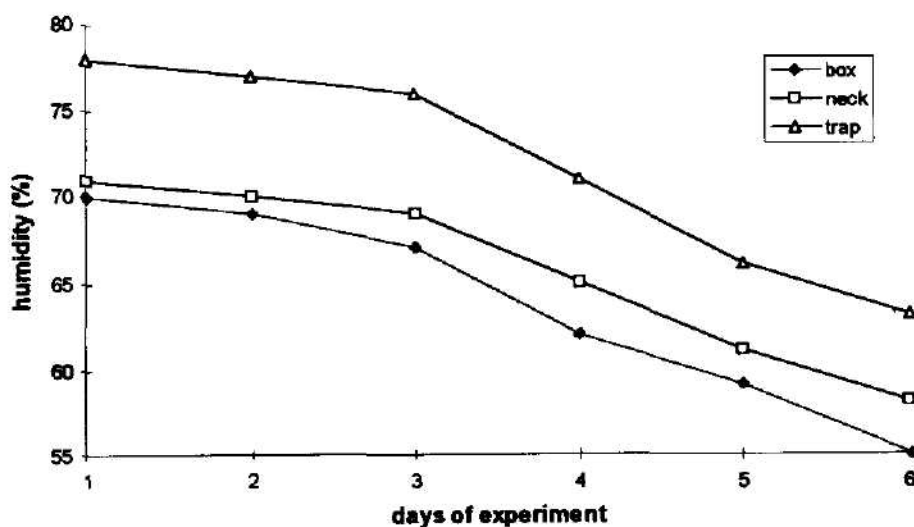


Fig. 1. The relative humidity during 6 days.

DISCUSSION

Comparative studies, pitfall traps vs suction sampling, revealed that pitfall traps capture fewer female and juvenile than male spiders. In suction samples the proportion of juveniles in cereals varied from 64–84%, while in pitfall traps it was only 5–10% (Dinter & Poehling 1992, Topping & Sunderland 1994). The male:female ratio was found to be close to 1:1 (Topping & Sunderland 1992), whereas in trap captures females were outnumbered by males.

The difference have been attributed to different locomotory activity of males, females and juveniles (Greenslade 1964, Basedow et al 1987, Adis 1979). Although, locomotory activity is species specific, it is assumed that male activity is generally higher due to search for mating (Dinter & Poehling 1992). Female activity is lower, as a result of post copulatory dispersal (Merrett 1967) and search for oviposition sites (Duffy 1956). However, the difference in activity may not be the very cause of variation in captures.

Tab 3 Times to death of different formaldehyde concentrations (s.d. = standard deviation)

	4 %	10 %	20 %	40 %
males	46 min	—	—	16 min
s.d.	2.64	—	—	0.92
females	1.44 hrs	49 min	18 min	17 min
s.d.	6.49	2.73	1.01	1.09
juveniles	5.55 hrs	47 min	32 min	14 min
s.d.	20.2	2.69	1.82	0.81

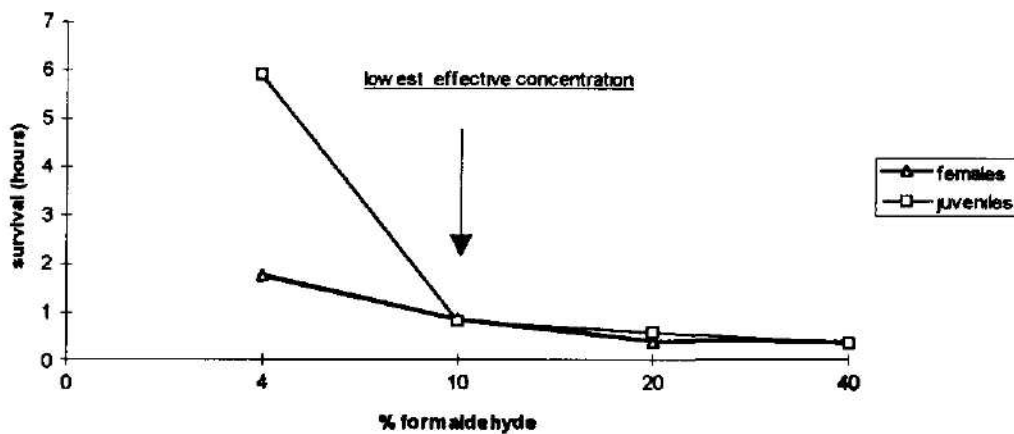


Fig 2 Plots describing survival of females and juveniles by various formaldehyde concentrations

According to my own experience in the open area, juveniles and females of *Pardosa* species are certainly not less active, but they tend to hide. Moreover, they occur in the summer (juveniles also in the autumn) when soils are prone to cracking under dry conditions. Cracks can harbour spiders (Sunderland & Topping 1994) and thus compete with pitfall traps. This is supported by the conclusions of the experiment, where both females and juveniles showed higher frequency of capture than males into water traps. On the contrary, Topping (1993) found out that males of *Erigone dentipalpis* showed higher encounter rates than females into empty traps. The difference seems to be obvious. Higher encounter of males result from their high locomotory activity, while higher capture rate of females and juveniles is due to their hiding behaviour.

It should be stressed that locomotory activity influence just the frequency of encounters with the trap, not the capture. As Topping (1993) pointed out, the common conceptual image of an animal blundering over the edge of the trap is certainly not the case with spiders. Most spiders usually turn away after an encounter. Thus, for instance, *Lepthyphantes tenuis* would need to encounter a trap 26 times to become captured (Topping 1993). Even for beetles the proportion of encounters resulting in capture were low (Halsall & Wratten 1988).

An important reason for differences in trap success seems to be the variation in escape ability. Surprisingly, juveniles showed much higher survival than adults, when put on a surface of 4% formaldehyde, even though one would expect the reverse. The reasons are not clear, probably physiological, because a spider is killed on the surface and its body sink under water after more than 12 hours. So the spider is rather killed by formaldehyde vapour than by the liquid. Only 40% concentration did not allow the spider to walk upon the surface, but to crawl, i.e. having body half submerged, and thus being killed rather by liquid than formaldehyde vapour.

The problem with the strong surface tension was solved by Basedow (1976) who recommended addition of few drops of a detergent into trapping fluid. However, its effect is still in question. While Waage (1985) showed that addition of detergent did not affect the catch of Coleoptera, Topping & Luff (1995) found the reverse for small linyphiid spiders. It is important to stress that they used ethylene glycol as trapping fluid which undiluted solution does not possess such strong surface tension as formaldehyde.

Original idea that higher trap success of males is a result of formaldehyde attractiveness was not proved. A repellent effect in the frequency of captures for both sexes and juveniles was observed, in contrast to conclusions of other authors (Adis 1979). The decrease in frequency could be related to avoidance as a result of experience, as supported by almost two times longer time to the first capture for formaldehyde fluid in moist conditions.

Of the external factors, only the effect of humidity was investigated. It was expected that desiccation of substrate in a box would increase frequency of capture. On the contrary, the frequency stayed the same during dry and moist conditions, while the time to the first capture was shorter under moist conditions.

CONCLUSIONS

To answer the question 'why formaldehyde pitfall traps capture less females and juveniles than males' more investigation should be done to obtain more reliable set of data. So far it is apparent that formaldehyde have not attractive, but repellent properties. And that females and juveniles are due to their hiding behaviour captured more frequently than males. Therefore, reasons responsible for capture inequality are attributed to individual survival and escape abilities. Longer survival of females and juveniles increases the probability of escape. Moreover, they exhibit spinning behavior that allows them, first to escape from the surface of formaldehyde, then to

leave the trap completely. These attributes prevent them from capture. On the other hand, in particular females and juveniles may treat pitfall traps as a shelter and that is why being attracted by pitfall traps.

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BOOK REVIEW

KING M. Species Evolution. The Role of Chromosome Change. Cambridge-New York-Melbourne: Cambridge University Press, 1993. xiv+336 pp. (reprinted 1994, paperback 1995)

This excellent monograph has been written by a cytogeneticist, stress is on the role of chromosomal rearrangements and molecular mechanisms in speciation processes in animals. However, the author has rare ability to integrate his special field of inquiry into a systematically arranged broader picture. He has been able to present the most up-to-date, complete and readable account of species and speciation hypotheses available so far. I believe that the list of titles and chapters alone shows the scope of this treatment, viz., "Introduction: genes, dreams and structural rearrangements, The species – what's in a name?, Genic differentiation, reproductive isolation and speciation in allopatric populations, Genetic revolution or gradual reform? Expectations of the founder effect, Chromosomal rearrangements as post-mating isolating mechanisms, The impact of structural hybridity on fertility and viability, Genic change and chromosomal speciation, Molecular mechanisms and modes of speciation, Conclusions and perspectives."

All the available species concepts and all the formulated hypotheses on speciation modes as well as the mechanisms involved are systematically, completely and lucidly covered without any preconceived bias. Reviews of hypotheses are always followed by detailed treatments of model situations – detailed enough, but summarized in a way that makes them interesting and understandable to everybody not directly concerned with the question or group. The author has definitely made his major point that chromosomal rearrangements without genic and ensuing phenotypic changes are valid mechanisms of speciation functioning in many differently categorized speciation processes.

To read this book is a must for all evolutionary biologists, cytogeneticists, microtaxonomists as well as for everybody involved with the study of species concept and speciation mechanisms, irrespective of whether they are approached from the molecular, chromosomal, population or higher levels of inquiry. I would nominate the book as the speciation book of the century, if there were such an award.

Pavel Štys

Contribution to the knowledge of distribution of *Myotis dasycneme* (Mammalia: Chiroptera) in the Czech Republic

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Abstract The new records of *Myotis dasycneme* (Boie, 1825) are summarized from the Moravian karst. The significant upward trend in the number of *M. dasycneme* records was found out within the Czech Republic, mainly during the winter period. The variability of the length of forearm and the weight is also discussed.

Distribution, winter and summer occurrence, *Myotis dasycneme*, the Moravian karst, Czech Republic

INTRODUCTION

Myotis dasycneme (Boie, 1825) is an arboreal relict Palearctic species with insular distribution in a broad band at 48°–60° N latitudes. The area of distribution extends from NE-France across Belgium, Holland, Germany, Denmark, S-Sweden, Poland, the Baltic states, Belorussia, Russia to W-Siberia (Jenisej river) and the Altai Mts. Distribution in the south of the region is across N-Italy, Hungary, Moldavia, Ukraine to the N-Kazakhstan (Horáček & Hanák 1989, Schober & Grimmberger 1989). The centres of distribution with nursery roosts occur in the Netherlands, Denmark and Lithuania (Schober & Grimmberger 1989). The distribution of *M. dasycneme* in central Europe has been summarized in detail by Feldmann (1963), Hanák & Gaisler (1965) and Horaček & Hanák (1989).

M. dasycneme is among the world's endangered bat species and Stebbings & Griffith (1986) estimated the W-European population at 3000 individuals. However, the assessment of the *M. dasycneme* population for the whole area of distribution is practically impossible because of scattered data from the eastern part of the region. Local populations are low in number and the *M. dasycneme* is a rare bat species in most countries throughout western and central Europe. This species was classified as endangered in the former Czechoslovakia (Baruš 1989).

M. dasycneme lives on wetlands during the summer period. Nursery colonies are reported most frequently in the lofts of churches (Voute 1972), but rarely in tree holes (Feldmann 1963). Together with *M. daubentoni*, *M. dasycneme* is often found in bat boxes (Dolch 1987). With regard to the flight abilities (straight and fast flight) and the character of the echolocation calls (long, shallow FM calls with low repetition rate) (Kapteyn 1991) it prefers mainly regions with an extensive network of slow-running water (Sluiter et al. 1971, Horáček & Hanák 1989). Streams are used as foraging areas, as well as flight corridors and route-identification elements during the migration of bats to the hibernacula (Anděra & Horáček 1982, Schober & Grimmberger 1989).

Underground spaces are used by *M. dasycneme* during the winter period. The bats migrate up to 300 km as the number of suitable hibernacula is limited in regions of summer distribution (e.g. Haensel 1987). It is generally accepted that the abundance of *M. dasycneme* at the hiberna-

cula decreases with distance from summer habitats (Hanák & Gaisler 1965). The populations from western Europe form nursery colonies in the lowlands of the Netherlands, Denmark and N-Germany, and migrate southward as far as N-Italy (Horáček & Hanák 1989). Solitary individuals from the above mentioned populations rarely hibernate in the northern mountains of the Czech Republic. The repeated hibernation of *M. dasycneme* was recorded in the Jizerské hory Mts. (Nevrlý 1987) and the Krkonoše Mts. (Flousek 1984, Horáček & Hanák 1989, Gaisler 1993, 1994). One hibernating individual of *M. dasycneme* was found in the Broumovsko region (Anděra & Vohralík 1982) and two individuals in the Jeseníky Mts. (Gaisler et al. 1993). In all cases the bats were found in mines. In 1973 *M. dasycneme* was also recorded in the Moravian karst again after many years of intensive bat research (Gaisler & Bauerová 1984). Since the eighties, *M. dasycneme* has regularly hibernated in this region. The presumed origin of hibernating *M. dasycneme* in the Moravian karst from the W-European populations is debatable in view of the summer records from the closer region of the Potiská lowland (Horáček & Hanák 1989).

The main aim of this article is to publish new data about *Myotis dasycneme*, obtained from the Moravian karst during the period 1990 to 1994, and to reveal current knowledge of its distribution from 1958 to 1994.

METHODS

All new winter records of *Myotis dasycneme* (1990–1994) came from 5 caves in the Moravian karst which were regularly censused in cooperation with the Management of the Protected Landscape Area Moravian karst, within the framework of the census of hibernating bats coordinated by the Czech Bat Conservation Trust. The method employed was that of visual census, thus minimising the risk of disturbance to hibernating bats (Bauerová et al. 1989). A telescope was used for the identification of bats hibernating in high shelters (over 4 m). In some cases bats were disturbed and taken from the shelters for precise identification.

The records from the period of the migrations (VIII–IX) are marked as summer records. All these records were obtained by means of netting at the entrances of three caves (Řehák 1995). Netted individuals were sexed, aged, measured, banded and immediately released. Only one individual was released one day after netting at a different place (homing experiment).

Differences in the sex ratio were analysed by chi-square test with Yate's correction (Pelikán 1984). Regression analysis was used to describe the effects of year on the abundance of bats. Samples containing the highest number of bats were used for this analysis if more than one census was organized during one winter season in the particular locality. The morphometric data (length of forearm and weight) were analysed by means of fundamental statistics and by one-way analysis of variance (ANOVA).

Explanations of the abbreviations in the following faunistic review: F – female, M – male, ad – adult, sad – subadult, juv – juvenile, a. s. l. – above sea level.

RESULTS

New faunistic data from the Moravian Karst

Winter records

6566* – Sloupsko-šošůvské caves, Sloup, d. Blansko – 24.1.1990 – 2 Fad, 1 Fad (Gaisler, Řehák), 17.1.1994 – 1 ind (Zukal, Řehák), 14.2.1994 – 1 ind. (Zukal, Řehák); 16.3.1994 – 6 ind. (Zukal), 14.4.1994 – 4 ind. (Zukal)

6666: – Kateřinská cave, Suchdol, d. Blansko – 17. 12. 1992 – 1 Mad; 4. 1. 1993 – 1 Fad, 1 ind.; 15. 1. 1993 – 1 ind., 28. 1. 1993 – 2 ind.; 11.2.1993 – 1 Fad, 1 ind., 25.2.1993 – 3 ind.; 11.3.1993 – 1 ind.; 24.3.1993 – 1 ind., 20.1.1994 – 1 ind.; 17.2.1994 – 1 ind. (Řehák, Zukal), – Suchožlebská zadržná cave, Vilémovice, d. Blansko – 20.1.1994 – 1 ind. (Zukal); – **Králova cave, Vilémovice, d. Blansko – 17.2.1994 – 1 ind. (Zukal).

6766: – Býčí skála cave, Habrůvka, d. Blansko – 10.2.1991 – 1 ind. (Zima, Horáček, Kovářik)

* the code of the square of the Czech mapping grid

** Horáček & Hanák (1989) erroneously mentioned an earlier record of the species in the Králova cave near Tišnov. Correction: Králova cave, Vilémovice d. Blansko – 6.2.1987 – 1 Msad (Gaisler)

Tab. 1 Summer records of *Myotis dasycneme* in the Moravian Karst from 1992 to 1993 (recaptures excluded). Explanations: F... number of females, M... number of males, s. i. ... sex indeterminate, * ... $p < 0.05$, ** ... $p < 0.01$, *** ... $p < 0.001$

Locality	F	M	χ^2	Σ
Sloupsko-šošůvské c.	2	8	2.50	10
Hladomorna c.	0	6	4.17*	6
Kateřinská c.	0	1	0.00	1
Total	2	15	8.47**	17

Summer records

6566 – Sloupsko-šošůvské caves – entrance, 460 m a. s. l., Sloup, d. Blansko – 26.8.1992 – 6 Mad (Řehák), 14.9.1993 – 1 Msad (Řehák, Zuka), 24.9.1993 – 1 Msad, 1 Fsad (Buřč); 25.9.1993 – 1 Fjuv (Buřč); – Hladomorna cave – entrance, 464 m a. s. l., Holštejn, d. Blansko – 24.8.1992 – 1 Mad (Řehák); 14.9.1993 – 1 Mad (Řehák, Zuka), 24.9.1993 – 1 Mad (Zima, Uhrin); 25.9.1993 – 1 Mad, 1 Msad, 1 Mjuv (Uhrin).

6666 – Kateřinská cave – entrance, 345 m a. s. l., Suchdol, d. Blansko – 24.9.1993 – 1 Mad (Gaisler, Zuka, Józsa).

In total, 33 records of *M. dasycneme* were registered in 5 caves of the Moravian karst during the winter periods. Three of these caves (Kateřinská c., Suchožlebská zadržná c. and Králova c.) are close to each other in the Suchý žleb valley and all caves are situated in the northern part of the Moravian karst with the exception of Býčí skála cave. The Sloupsko-šošůvské caves and Kateřinská cave, where 90.9% of records were made, are visited by tourists throughout the year. In total, 81.8% of records were not identified to sex, and the dominance of females was statistically insignificant due to the number of sexed individuals being low ($N=6$, $\chi^2=1.50$, $p>0.05$). Hibernating bats were found in shallow vertical holes of cave ceilings or walls at heights over 3 meters.

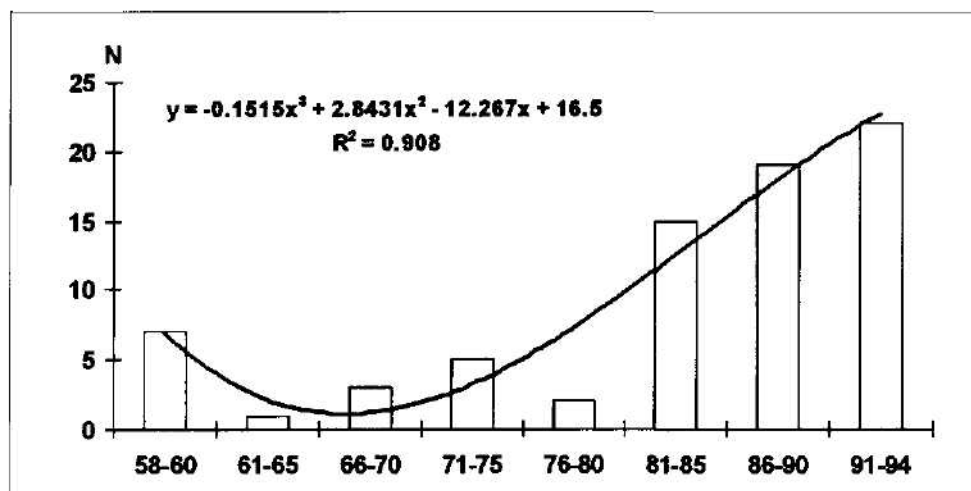


Fig. 1 Temporal distribution of the sample of *Myotis dasycneme* in the Czech Republic (winter records only).

Tab. 2. Winter records of *Myotis dasycneme* in the Czech Republic from 1958 to 1994. Explanations viz. Tab. 1

Locality	F	M	χ^2	s. i.	Σ
Bílá Desná	4	3	0.00	0	7
Nové Město pod Smrkem	4	1	0.80	1	6
Herlíkovice	22	5	9.48**	11	38
Adršpach	0	1	0.00	0	1
Malá Morávka	2	0	0.50	0	2
Sloupsko-šošůvské c.	3	1	0.25	13	17
Erichova c.	1	0	0.00	0	1
Kateřinská c.	7	2	1.78	12	21
Králova c.	0	1	0.00	1	2
Suchožlebská zadržaná c.	0	0		1	1
Býčí skála c.	0	0		2	2
Total	43	14	13.75***	32	98

Summer nettings of *M. dasycneme* at the entrances of three caves were the first records of this species in the Czech Republic during the non-hibernation period. In total, 17 specimens were netted and two of them were recaptured the following day. These recaptures were registered only at the entrances of the Sloupsko-šošůvské caves and the Hladomorna cave i. e. the caves on the northern edge of the Moravian karst. One male netted during flight into the Sloupsko-šošůvské caves (24.9.1993 at 21.00 CET) was released the following morning near Skalní mlýn field station which is situated cca 6 km south of the netting site. This individual was again captured on September 25 (22.55 CET). The male specimen recorded at the Hladomorna cave was also caught on two consecutive nights, (24.9. and 25.9.1993). The samples of nettings showed a statistically significant dominance of males (Tab. 1).

Assessment of records from 1958 to 1994 in the Czech Republic

In total, 115 records of *Myotis dasycneme* were made at 12 localities in the Czech Republic during the period 1958 to 1994; 98 records (85%) were in the winter period and 17 individuals (15%) were caught during the non-hibernation period (Tab. 1, 2). Five localities are situated in the northern part of the Czech Republic – two in the Jizerské hory Mts. (Bílá Desná, Nové Město pod Smrkem) and one each in the Krkonoše Mts. (Herlíkovice), the Broumovsko region (Adršpach) and in the Jeseníky Mts. (Malá Morávka). Seven localities (58.3%) are in the Moravian karst. Hibernating specimens of *M. dasycneme* were found in 6 caves of this region, in 4 of them repeatedly. Only active individuals were registered at the entrance to the seventh cave (Hladomorna cave). 61 (53.0%) of all records in the Czech Republic were from the Moravian karst. The proportion of winter records in caves of the Moravian karst from the total winter records in the Czech Republic amounted to 44.9%. The temporal distribution of *M. dasycneme* records in the Czech Republic indicate a slight upward trend in abundance from 1958 to 1994 (Fig. 1).

The highly significant dominance of females was revealed in the summary of winter records (Tab. 2), contrary to the summer records from the Moravian karst (1992, 1993).

Variability of the length of forearm and the weight

Evaluation of variability of the forearm length and the weight was carried out on the data from 3 regions: 1. the Moravian karst (17 males, 5 females); 2. Jizerské hory Mts. and Krkonoše Mts.

(3 males, 5 females) (Hanák & Gaisler 1965, Flousek 1984) and 3. Germany – Mecklenburg, Bad Freienwalde, Rüdersdorf (11 males, 16 females) (Haensel 1985, Labes 1992). Analysis by means of a one-way ANOVA showed no significant differences in the weight of *M. dasycneme* between various samples i. e. with respect to particular regions (1, 2, 3), to different periods of year (winter, summer) or to sex (males, females).

On the other hand, there were the significant differences in the forearm length of males and females in the material pooled from all localities (ANOVA: $F=6.244$, $p=0.0158$, $d.f.=1$; 50). In general the females had longer forearm (females: $N=23$, $\bar{x}=45.8$ mm, $S.D.=1.568$, $S.E.=0.327$, resp. males: $N=29$, $\bar{x}=44.9$ mm, $S.D.=1.109$, $S.E.=0.206$). Similar result had been revealed by the evaluation of sample from the Moravian karst (ANOVA: $F=7.111$, $p=0.0176$, $d.f.=1$; 15) (females: $N=2$, $\bar{x}=46.8$ mm, $S.D.=1.626$, $S.E.=1.150$, resp. males: $N=15$, $\bar{x}=44.5$ mm, $S.D.=1.053$, $S.E.=0.272$). One-way ANOVA also showed statistically significant differences between summer samples of males from the Moravian karst and from the Mecklenburg (Germany) (ANOVA: $F=6.052$, $p=0.0256$, $d.f.=1$; 16; Mecklenburg: $N=4$, $\bar{x}=46.1$ mm, $S.D.=1.117$, $S.E.=0.558$, Moravský kras: $N=14$, $\bar{x}=44.6$ mm, $S.D.=1.059$, $S.E.=0.283$) (Fig. 2).

DISCUSSION

The significant upward trend in a number of *M. dasycneme* records within the Czech Republic indicates a slight enlargement of the area of distribution, mainly during the winter period. The hibernation of *M. dasycneme* in the Moravian karst was reported in the first half of the last century (Kolenati 1860). Although the systematic research of bats hibernating in caves of the

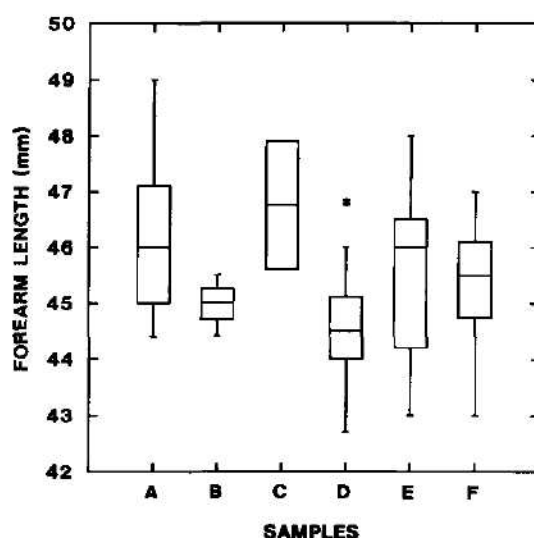


Fig. 2. Box-and-whisker graph of the forearm lengths for particular localities and sexes. Explanations: A, B – material from the Czech Republic excluding Moravian Karst (females and males); C, D – material from the Moravian Karst (females and males); E, F – material from Germany (females and males).

Moravian karst was initiated by Gaisler as early as in 1957, *M. dasycneme* was found for the first time in 1973 (Gaisler & Bauerová 1984). Next records in 1982, 1984, 1987 and 1988 concern solitary individuals (Gaisler & Bauerová 1984, Horáček & Hanák 1989) and can be considered isolated cases of occurrence. Since 1989 *M. dasycneme* has been recorded in the Moravian karst every year. It was found hibernating most frequently in the Sloupsko-šošůvské caves and Kateřinská cave, i. e. the caves where this species was recorded by Kolenati (1860). At the entrance of these caves *M. dasycneme* was also netted during autumn migrations. Therefore, both the above mentioned caves can be considered as regular hibernacula of *M. dasycneme*. The Sloupsko-šošůvské caves are the most important shelter, where the number of both winter and summer records was highest. The successful homing experiment verifies that the visits of bats to the Sloupsko-šošůvské caves are not random and the bats „know“ these caves. This fact also confirms the importance of social tradition for the choice and use of the hibernacula (Horáček & Zima 1978). The recaptures of particular individuals during two consecutive nights show that the autumn visits to the caves are not single. The winter records from the Králova and Býčí skála caves are not also the first (see Horáček & Hanák 1989) and the only new locality for the occurrence of *M. dasycneme* was the Suchožlebská zadržná cave.

The regular occurrence of *M. dasycneme* in the Moravian karst demonstrates that this area is important for both its hibernation and the late summer and autumn migrations. The dominance of males in summer samples could be explained by the later beginning of cave visitation by females (Horáček & Zima 1978). On the other hand, the high dominance of females in the hibernacula of the Czech Republic might be influenced by the use of less accessible parts of caves by males, or by the use of shelters other than caves. It is possible that the males netted at the entrances of caves in the Moravian karst are using this area as a temporary shelter during migration to others regions. The dominance of females in the whole winter sample from the Czech Republic is also significant if the sample from locality Herlíkovice is excluded. This is the only locality with statistically significant difference in sex ratio of *M. dasycneme*.

The females have longer forearms than males in the Moravian karst in spite of the lower number of females in the sample. Considerable differences of the forearm length between sexes were also found in pooled data (3 different regions). Nevertheless, more data are required for a detailed analysis of differences between regions.

Acknowledgements

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BOOK REVIEW

KLEINIG H. & SITTE P. **Zellbiologie. Ein Lehrbuch. Third revised edition** Stuttgart-Jena-New Gustav Fischer Verlag, 1992, XI+591 pp. Format 190×270 mm, hardcover, price DM 128 00, ISBN 3-437-20482-3

The authors are professors at the Albert Ludwig University in Freiburg. As indicated in the preface, the five years since the last edition in 1986 have seen major advances in the cell biology. Emphasized in this book are new developments in molecular biology and genetics, especially in thematic fields relating to immune and tumour cells, to signal transduction, molecular chaperones, transmembrane protein transport, photosynthesis, DNA organelles, HIV, and genome sequencing. The contents of this volume has been divided into three thematic parts and 23 chapters.

In the first, most extensive part (12 chapters) „Cells and organelles“ are presented when discussing the organization of protozoocytes and eucytes, cellular compartmentation, extracellular genetic elements, cellular energetics, biomembranes, cell surface, cytoplasm and its components - the cytoskeleton, filaments and microtubuli, centrioles, spasmonemes, various inclusions etc. Further on examined are the nucleus and nuclear genome, ribosomes and protein synthesis, endomembrane systems and endocytosis, microbodies, mitochondria and respiration, plastids and photosynthesis, and the cell walls.

In the second part (7 chapters) discussed are „Special types of cells and their performance“. This part deals with gametes and syngamy, nervous and sensory cells, and signal transduction pathways, with chemotaxis and phototaxis, with muscle cells and motile systems, with blood, haemopoietic cells and the immune system, and with morphological, chemical and genetic aspects of tumour cells.

In the third part (4 chapters) „Proliferation, differentiation and evolution of cells“ described are the cell cycles of protozoocytes and eucytes, and growth factors and multiplication of animal and plant cells in cultures. The cell differentiation is treated with a view to some model systems – to sporulation in *Bacillus subtilis*, aggregation of amoeboid cells in *Dictyostelium discoideum*, life cycle of the giant algal cell of *Acetabularia acetabulum*, and the colony of *Volvox carter*. The cytosymbiosis and cell evolution are reviewed here considering miscellaneous biological associations, and biochemical, phylogenetic and genetic aspects.

In the appendix some technical data are given on measures, units and constants with their symbols, on light, polarization and electron microscopes, on videomicroscopy, confocal laser microscopy, and on cell fractionalization. In conclusion, there is glossary of cellular and molecular biology methods, and an overview of historical data in the cell biology.

The text is extensively augmented by 515 illustrations – line drawings and schematic presentations of molecular and cellular structures, and light and electron microphotographs. In addition, there are 82 tabular reviews which summarize textual informations. Many drawings are presented in two colours. Besides, there are many „boxes“ which are featured in the main text by frames and highlight various biological phenomena. This volume offers a comprehensive compendium to students and professional lecturers in biological sciences.

Jindřich Jira

New taxa of Collembola (Entognatha) from the Czech Republic

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Abstract New genus and species *Bathytterra bipartita* gen. n. and sp. n. (Isotomidae) and *Mesaphorura jevanica* sp. n. (Onychiuridae) from Bohemia (Czech Republic) are described.

Taxonomy, descriptions, new genus, new species, Collembola, Isotomidae, Onychiuridae, *Bathytterra* gen. n., Palaearctic region

Bathytterra gen. n.

DIAGNOSIS Member of the subfamily Anurophorinae (family Isotomidae). Body shape resembling *Cryptopygus* Willem, 1902. White, without trace of pigmentation. Body surface smooth, without secondary granulation. Without eyes. Postantennal organ simple, almost elliptical. Antennal segment IV without apical vesicle. Chaetotaxy plurichaetose, without trichobothria. Tibiotarsus divided ventrally by suture into two parts. Abdominal segments V+VI fused dorsally. Anal spines absent. Furca well developed. Manubrium with 1+1 ventral chaetae. Dentes bearing dorsal crenulation in medial part, mucro with three dorsal and two basal lateral teeth.

TYPE SPECIES *Bathytterra bipartita* sp. n.

AFFINITIES The new genus is related to *Cryptopygus* Willem, 1902 and differs from it clearly by the tibiotarsi being divided ventrally into two parts in all three pairs of legs.

DERIVATIO NOMINIS The generic name is composed from bathys (= deep) and terra (= soil) living deep in soil, feminine.

Bathytterra bipartita sp. n. (Figs 1–4A)

DESCRIPTION (all measurements from holotype) Body 1400 µm long, white, without trace of pigmentation. Integument of the whole body smooth (in light microscope), without secondary granulation. Chaetotaxy plurichaetose, as in Figs 1A, B. Chaetae 17–70 µm long, smooth, well differentiated into macro and microchaetae (Figs 1A, B). Formula of macrochaetae (Figs 1A, B) 11/3334, lateral macrochaeta on meso and metanotum 65 µm long. Formula of sensilla (Figs 1A, B) 53/32235. Sensilla on abdominal segments V+VI 10–25 µm long (Fig. 1B). Lateral sensilla complex on meso and metanotum as in Fig. 1A.

Head 240 µm long and 230 µm wide. Antennal segments I, II, III and IV as 40, 60, 60 and 105 µm long, respectively. Antennal segment I with 13 common chaetae, three sensilla (one dorsal, two ventral) and two basal, 5 µm long microchaetae (one ventral and one dorsal) (Figs 2A, B). Antennal segment II (Fig. 2A) with one 12 µm long sensillum anterolaterally, one basal microchaeta and ca. 50 common chaetae. Antennal organ III consists of two thin, 11 µm long

sensilla, two 6 μm long, slightly thickened microsensilla between them and one thin, 4 μm long microsensilla ventrally (Fig. 2C). Antennal segment IV (Figs 2C, D) with many thin or slightly thickened, 10–18 μm long sensilla among common chaetae; subapically with 2 μm long microsensillum and one slightly curved, 7 μm long sensillum (without apical or subapical vesicle).

Postantennal organ almost elliptical, 27 μm long and 6 μm wide (Fig. 2E). Eyes absent. Chaetotaxy of labrum 3/554 (Fig. 3A). Maxillar outer lobe as in Fig. 3B. Mandible with well developed molar plate and apical dentate part, maxilla as in Fig. 4A.

Tibiotarsi of all three pairs of legs ventrally divided by suture into two parts (Figs 3C, D). Distal part of tibiotarsi with one ring of chaetae. Apical tibiotarsal chaetae acuminate. Claw slim, 55 μm long, without teeth; empodial appendage 26 μm long, without teeth (Figs 3C, D). Thoracal sterna without chaetae. Ventral tube with 7 distal chaetae on each side and six posterior chaetae. Retinaculum with 4+4 teeth on rami and one chaeta on corpus. Furca well developed (Fig. 3E). Manubrium with 1+1 ventral chaeta. Dens crenulated dorsally in the middle part, with 5 dorsal and 10 ventral chaetae (Fig. 3E). Mucro with three large dorsal and two lateral, spinelike basal teeth (Fig. 3E). Manubrium: dens: mucro as 115:120:33 (μm). Furcal anterior subcoxae with 17 chaetae and posterior ones with one 67 μm long macrochaeta and 3 common chaetae. Female genital plate with two microchaeta on anterior as well as posterior lid.

HOLOTYPE female No. 20.4.1994/B173 and 25 paratypes in author's collection, Institute of Soil Biology, Academy of Sciences of the Czech Republic.

LOCUS TYPICUS. Czech Republic, Bohemia occidentalis, Sokolov, on water surface in a hydrological drill 8.2 m below the soil surface, 20.4.1994, 26 specimens, leg. M. Fiala.

ECOLOGICAL NOTES. The new species probably lives in interstitial spaces deep in the soil and was sucked up with ground water into the soil drill and then transported to the surface. The drill was used for pumping ground water polluted by oil (the mixture was brought to the soil surface for cleaning).

DERIVATIO NOMINIS. The species name is derived from the two-part division of the tibiotarsi.

Mesaphorura jevanica sp. n. (Figs. 4B, 5)

Mesaphorura sp. n.: Rusek, 1996.

DIAGNOSIS. Body 580 μm long. White. Lateral sensillum s on meso and metanotum slim; sensillum p₁ on abdominal tergite V slightly thickened, spindle-shaped. Macrochaetae mostly not very long, 1.7–3.7 times longer than microchaetae. Meso and metanotum with a₂ macrochaeta. Abdominal tergite IV with p₁ macrochaeta and p₂ microchaeta; chaeta m₃ absent. Abdominal tergite V with 3+3 microchaetae between a₄ macrochaetae. Formula of pseudocelli: 11/011/10011. Pseudocelli on meso and metanotum behind p₄ chaetae. Antennal segment IV with thickened sensilla a e. Antennal organ III of typical *Mesaphorura* Bag, 1915 shape. Postantennal organ narrow, with 32 simple vesicles in two parallel rows. Anal spines shorter than claw. Anal lobes with complete set of chaetae, l₂' present. Only females known.

DESCRIPTION (all measurements from holotype). Body elongated (Figs 5A, B), 580 μm long and 110 μm wide. White. Granulation of whole body fine and uniform, only on abdominal tergite VI slightly coarser and sparser. Chaetae on nota and abdominal tergites I–IV slightly differentiated into macro and microchaetae, macrochaetae 1.7–2.5 times longer than microchaetae; macrochaetae on abdominal tergites V–VI well differentiated, 2.5–3.7 times longer than microchaetae (Fig. 5B). Dorsal chaetotaxy as in Tab. 1.

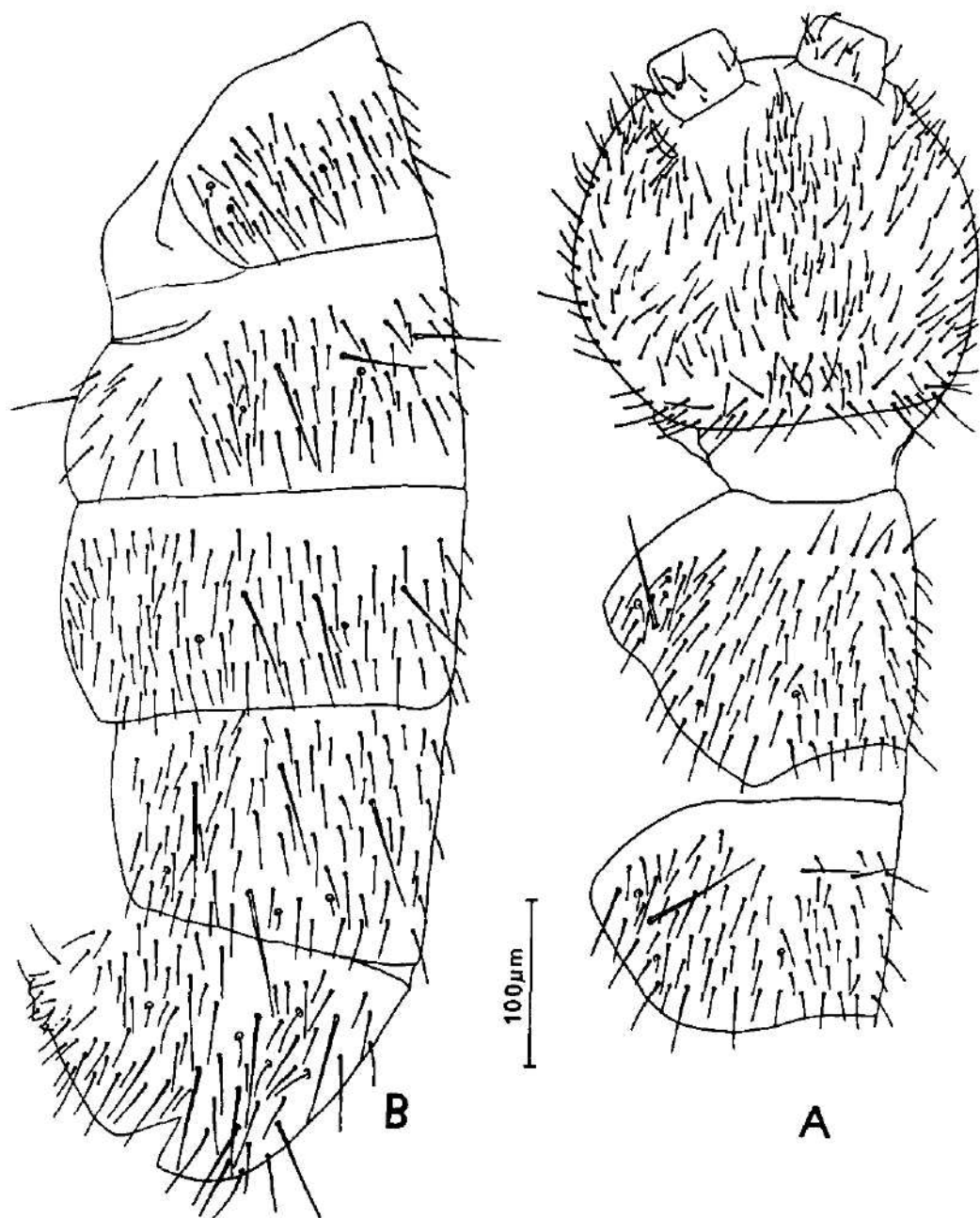


Fig. 1. *Bathytarra bipartita* gen. n. et sp.n. (holotype). A dorsal chaetotaxy of head, meso- and metanotum. Scale: A, B 100 µm.

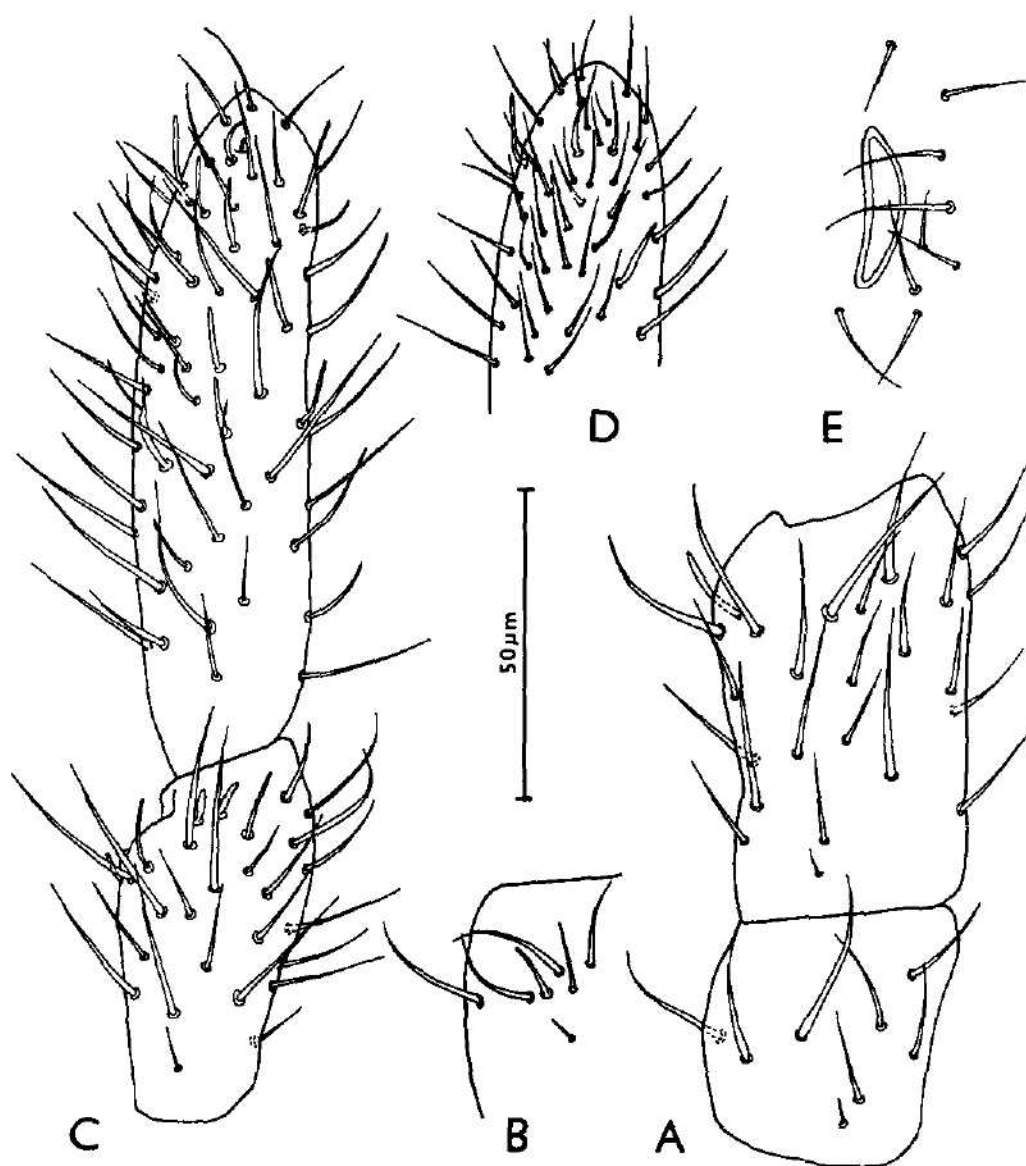


Fig. 2. *Bathytarra bipartita* gen. n. et sp. n. (holotype). A dorsal chaetotaxy of antennal segments I II, B ventroexternal chaetotaxy of antennal segment I, C dorsal chaetotaxy of antennal segments III IV, D ventral chaetotaxy of distal part of antennal segment IV, E postantennal organ. Scale: A-E 50 µm.

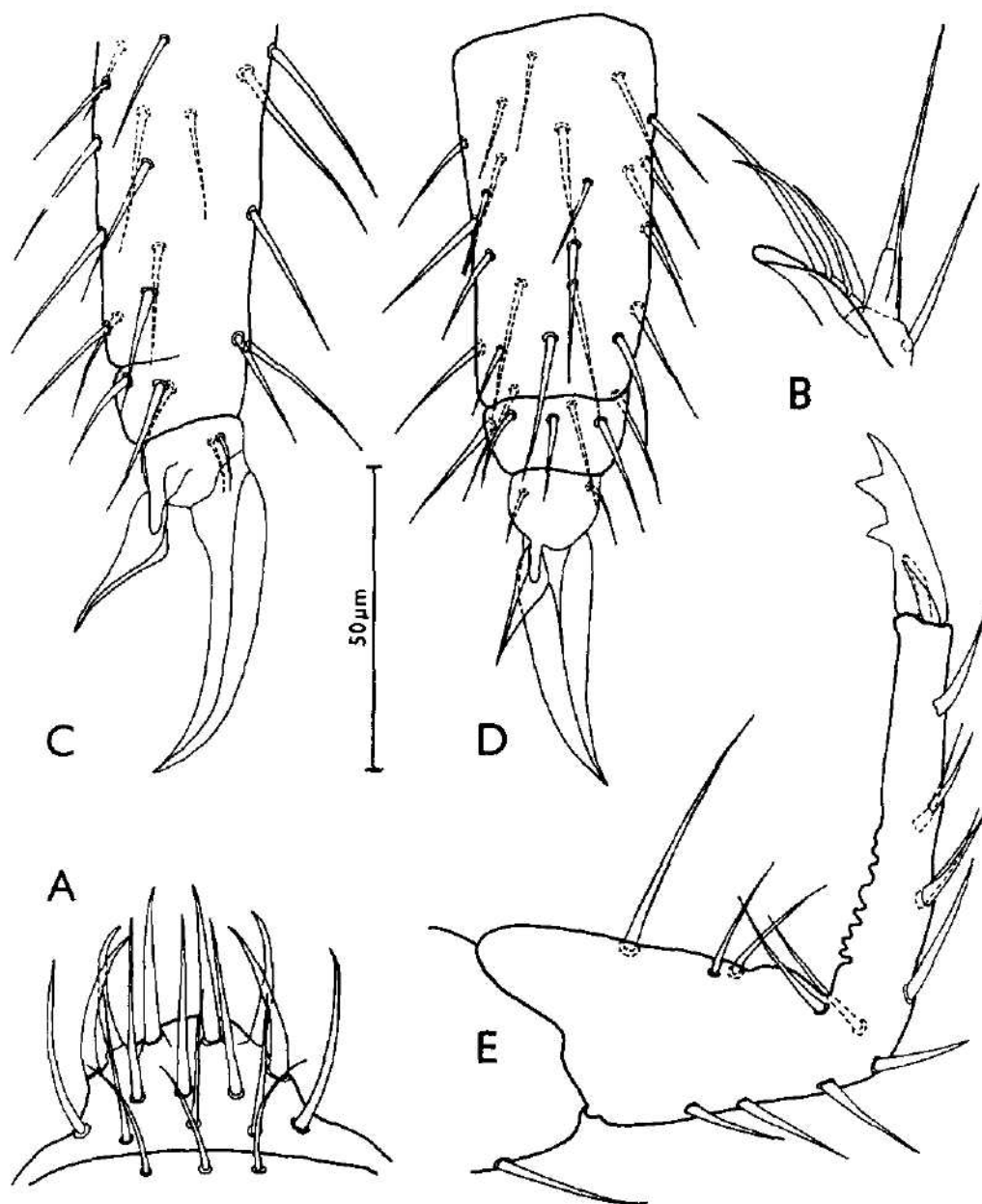


Fig. 3. *Bathytarra bipartita* gen. n. et sp. n. (holotype). A chaetotaxy of labrum, B chaetotaxy of outer lobe of maxilla, C chaetotaxy of tibiotarsus and claw III, lateral view, D ventral side of tibiotarsus and claw II, E furca. Scale: A–E 50 µm.

Tab. 1. Dorsal chaetotaxy formula in *Mesaphorura jevanica* sp. n. ¹ m₄ present; ² m⁴ (microchaeta) present and m₅ absent, ³ p₁ is macrochaeta and p₂ microchaeta, ⁴ p₃ is slightly thickened sensilla (s=8 µm, p₂=16 µm) (Fig. 5B)

	I	II	III	I	II	III	IV	V
a	8	10	10	10	10	10	10	10
m	8	8	8	2 ¹	2	2	2 ²	-
p	-	8	8	10	10	10	10 ³	8 ⁴
p ₁	2	3	3	2	3	3	4	1

Lateral sensillas on meso and metanotum not thickened, 16 µm long. Sensory rods (on meso and metanotum 2 µm long, in small pit. Macrochaeta a₂ on metanotum 10 µm long, microchaeta a₁ 7 µm long. Lengths of some chaetae on abdomen: tergite IV a₁ 7 µm, a₂ 15 µm, p₁ 13 µm, p₂ 7 µm, p₃ 15 µm, p₅ 15 µm, tergite V a₁ 7 µm, a₂ 9 µm, a₃ 7 µm, a₄ 16 µm, sensilla p₅ 16 µm. Chaetotaxy of anal lobes complete, chaeta l'₂ and l'₃ present.

Pseudocelli circular, 8 µm in diameter, with starlike center (Figs 5A, B). Pseudocellar formula (Figs 5A, B): 11/011/10011. Those on meso and metanotum behind chaeta p₄.

Antennae shorter than head, as 68 µm: 85 µm (Fig. 5A). Lengths of antennal segments I, II, III, IV 13, 15, 20, 20 µm. Antennal segment IV (Fig. 4B) with five sensilla a e, two sensory rods f and g, and globular apical papilla. Antennal organ III (Fig. 4B) consists of two small sensory rods concealed behind integumental fold and two thick sensory clubs bent toward each other. Thick, short sensory club present on the ventral side of antennal segment III (Fig. 4B).

Postantennal organ, 15 µm long and 4 µm wide, with 32 simple vesicles in two parallel rows.

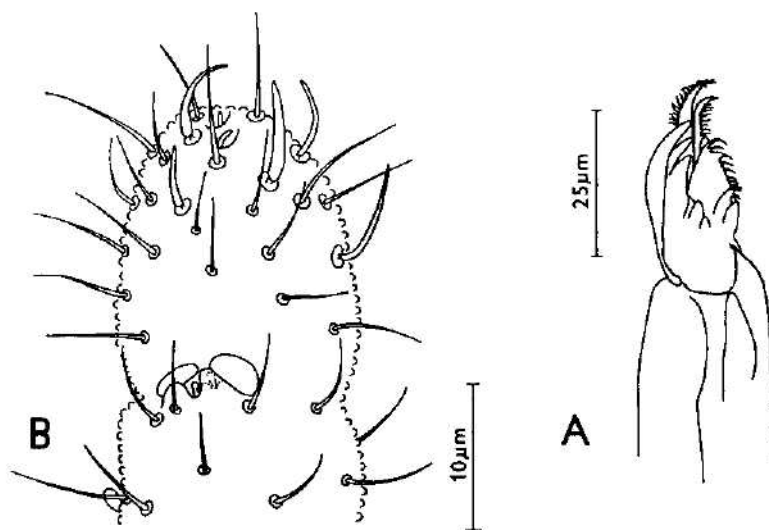


Fig. 4. *Bathytarra bipartita* gen. n. et sp. n. (holotype). A head of maxilla. *Mesaphorura jevanica* sp. n. (holotype). B dorsal chaetotaxy of antennal segments III IV. Scales: A 25 µm, B 10 µm.

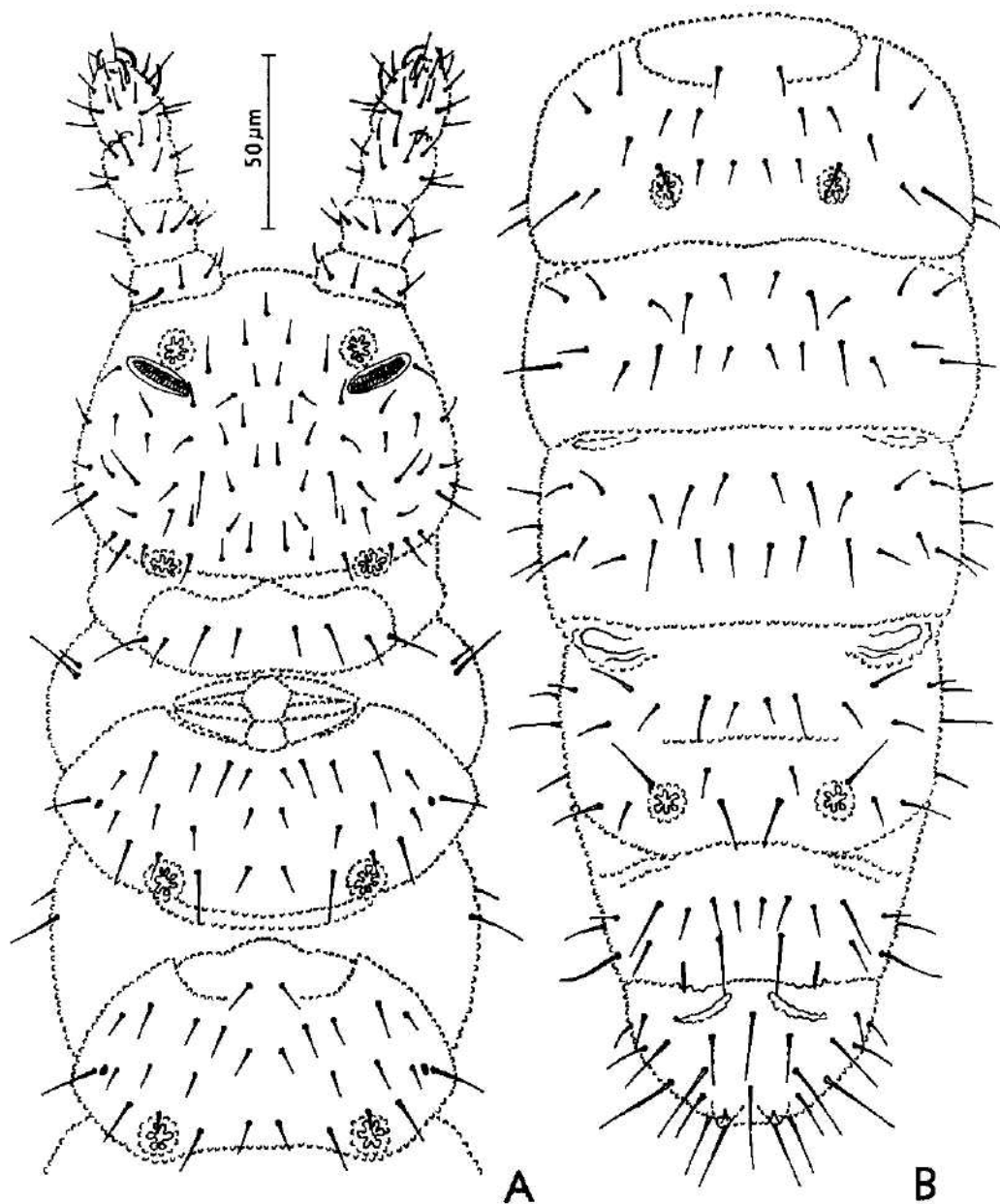


Fig. 5. *Mesaphorua jevanica* sp. n. (holotype). A dorsal chaetotaxy of head and nota, B dorsal chaetotaxy of abdomen. Scale: A, B 50 μ m.

Legs short, without knobbed tibiotarsal hairs. Claw without teeth, 11 μm long. Empodial appendage 2 μm long, without inner lamella.

Abdominal tergite IV divided by transverse groove into anterior and posterior parts (Fig. 5B). Abdominal tergite VI with two anal spines on low papillae (Fig. 5B). Length of anal spines (without papillae) 8 μm . Two crescentic ridges on anterior margin of abdominal tergite VI present (Fig. 5B).

Ventral tube with 6+6 chaetae. Venter without trace of furca. Only females known.

AFFINITIES. *Mesaphorura jevanica* sp. n. is near to *M. macrochaeta* Rusek, 1976 and to *M. yosii* (Rusek, 1967). All have 3+3 median microchaetae in the anterior row between a_4 macrochaetae on abdominal tergite V and complete set of chaetae (l'_2 present) on anal lobes. The chaeta m_5 is present on abdominal tergite IV in *M. macrochaeta* and absent in *M. yosii* and *M. jevanica* sp. n. In *M. macrochaeta* and the new species p_1 is macrochaeta and p_2 microchaeta on abdominal tergite IV, in contrast to *M. yosii* (p_1 microchaeta and p_2 macrochaeta). The very long macrochaetae are conspicuous in *M. macrochaeta*, whereas they are less differentiated in *M. yosii* and *M. jevanica* sp. n.

HOLOTYPE female No 25.10.1994/B331 and 8 paratypes in author's collection, Institute of Soil Biology, Academy of Sciences of the Czech Republic.

LOCUS TYPICUS. Czech Republic, Bohemia centralis, Jevany (about 35 km east of Praha), Voděradské Bučiny Natural Reserve, Lesní Potok Catchment, U Kazatelny, 445 m ASL, in soil samples from the forest community *Luzuleto-Fagetum cladonietosum* (type with *Dicranum scoparium*). Soil type: shallow ranker soil without litter layer, 25.10.1994, 9 specimens, leg. J. Rusek.

FURTHER LOCALITIES. As in Locus typicus, but on the hill „Nad Farmou“, 445 m ASL, in soil samples from the forest community *Luzuleto-Fagetum-cladonietosum* (type with *Dicranum scoparium*), soil type: shallow ranker without litter layer, 3.5.1971, 12 specimens; as in Locus typicus, but on the east slope of the hill „Nad Farmou“, 425 m ASL, in soil samples from the forest community *Luzuleto-Fagetum typicum*, soil type: cambisol with 5–10 cm deep litter layer, 3.5.1971, 7 specimens; as in Locus typicus, but on plateau below Hraněná Olšina in the Lesní Potok Catchment, 480 m ASL, in soil samples from the forest community *Carpineto-Fagetum*, soil type: cambisol with 2–3 cm deep litter layer, 17.5.1995, 30 specimens, for all localities J. Rusek leg.

ECOLOGICAL NOTES. This new species is common in different beech forest communities in the Voděradské Bučiny Natural Reserve.

DERIVATIO NOMINIS. The species name is derived from the village Jevany (Locus typicus), where the II International Colloquium on Apterygota, 1973, took place.

Acknowledgements

I am very obliged to Dr M. Fiala, Brno, for the material of *Bathytarra bipartita* gen. n. sp. n. and to Dr V. G. Marshall, Victoria, B. C., Canada, for improving the manuscript. The material of *Mesaphorura jevanica* sp. n. was collected when working on the ecological grant project No 206/93/0276 supported by the Grant Agency of the Czech Republic.

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A report on Leiodinae (Coleoptera: Leiodidae) of India

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Abstract. *Dermatohomoeus kejvali* sp. n. and *Pseudocolenis boukali* sp. n. from India are described and distinguished from similar species *Dermatohomoeus silvaticus* (Hlisenkovský, 1972) and *Colenisia besucheti* (Hlisenkovský, 1972) are recorded from India for the first time. Some faunistic data about SE Asian Leiodinae are added. All Indian species of the tribes Leiodini and Pseudoleiodini are listed.

Taxonomy, new species, faunistics, Leiodinae, India, SE Asia

INTRODUCTION

The species of the tribes Leiodini and Pseudoleiodini have been studied mainly by Daffner (1982, 1983a, 1983b, 1985, 1986, 1988a, 1988b, 1990, 1991) who described 37 species from India. All species known from the region with data about distribution and references are listed in the Appendix. Through the kindness of David Boukal and Zbyněk Kejval I get a possibility to study a rich material contents 16 species in more than 200 specimens of the tribes Leiodini and Pseudoleiodini from Southern India. Two of them are new to science – *Dermatohomoeus kejvali* sp. n. and *Pseudocolenis boukali* sp. n. and they are described below. Another two species – *Dermatohomoeus silvaticus* and *Colenisia besucheti* are recorded from India for the first time. Most of the species collected by D. Boukal and Z. Kejval were known only as the types till now. Another species I have received for the studies from Svatopluk Bílý, Miroslav Snížek and from unknown collector. This material contains *Pseudocolenis strigosa* and *Colenisia luteicornis* new to Thailand.

MATERIAL AND METHODS

The most of material have been collected by D. Boukal and Z. Kejval and it is coming from the localities listed below. The material was obtained by sifting. There are used the abbreviations of the localities indicated in the following list.

- 1 S[outhern] India, Kerala, Cardamom Hills, 30 km W Kumily, Permaade, 900 m [above sea level], 25 xii 1993, 09° 34' N 76° 59' E, Boukal D. & Kejval Z. lgt. Abbreviation S India, Permaade
- 2 S[outhern] India, T. Nadu, Nigiri Hills, 15 km SE Kotagiri, Kunchappanai, 900 m [above sea level], 17 – 28 xi 1993, 11° 22' N 76° 56' E, Boukal D. & Kejval Z. lgt. Abbreviation S India, Kunchappanai
- 3 S[outhern] India, Kerala, Cardamom Hills, 15 km SW Munnar, Kallar Valley, 1000 m [above sea level], 6 – 18 xii 1993, 10° 02' N 76° 58' E, Boukal D. & Kejval Z. lgt. Abbreviation S India, Kallar Valley
- 4 S[outhern] India, Kerala, Cardamom Hills, 10 km SW Kumily, Vallakadavu, 24 xii 1993, 1000 m [above sea level], 09° 31' N 77° 07' E, Boukal D. & Kejval Z. lgt. Abbreviation S India, Vallakadavu
- 5 S[outhern] India, T. Nadu, Nigiri Hills, Kotagiri env., St. Catherine Falls, 15.xi.1993, 11° 23' N 76° 52' E, Boukal D. & Kejval Z. lgt. Abbreviation S India, St. Catherine Falls
- 6 S[outhern] India, Kerala, Cardamom Hills, 300 m [above sea level], 50 km NW Pathanamthitta near Pambaiyar river, 27 – 29 xii 1993, 09° 25' N 77° 05' E, Boukal D. & Kejval Z. lgt. Abbreviation S India, Pathanamthitta.

Further are used the following abbreviations: Collection of Z. Švec (Praha) = CZS, coll. D. Boukal (České Budějovice) = CDB

RESULTS

Leiodini

There are 20 species of the tribus Leiodini known from India. One of them was examined.

Zeadolopus piceatus (Hlisnikovský, 1972)

Cyrtusa piceata Hlisnikovský, 1972: 146, 148

MATERIAL EXAMINED. 1 spec., S. India, Kallar Valley. Deposited in CZS.

DISTRIBUTION. Sri Lanka, India.

Pseudoliadini

There are 36 species of the tribus known from India. Altogether 17 species of them including the two new to science were examined.

Dermatohomoeus kejvali sp. n.

TYPE MATERIAL. Holotype, male, S[outhern] India, T. Nadu, Nilgiri Hills, 15 km SE Kotagiri, Kunchappanai, 900 m [above sea level], 17.–28 xii 1993, 11°22' N 76°56' E, Boukal D. & Kejval Z. lgt. Deposited in CZS.

Length of body 1.6 mm, head 0.2 mm, pronotum 0.4 mm, elytra 1.0 mm, antenna 0.5 mm, width of head 0.4 mm, pronotum 0.9 mm, elytra 0.9 mm.

Chestnut colored, antennae, legs and mouth a little lighter. Dorsum rarely lightly haired.

HEAD. Smooth except hind transversely strigose part reaching to posterior margin of eyes. Distinctly punctured. Punctures well developed, separated by 2–3 times their diameter. Eyes large, prominent. 9th antennal segment longer than wide.

PRONOTUM. Smooth, slightly punctured. Punctures about 4 times smaller than those on head, separated by 4–7 times their diameter. Hind angles pull out posteriorly in dorsal view and rounded, rectangular in lateral view.

ELYTRA. Distinctly transversely strigose. Punctures distributed in strigosites evidently arranged in rows. Rows separated by 3 times of punctures diameter. Sutural stria reached to the 1st third of elytral length.

METASTERNUM. Membraneous wings fully developed.

GENITALIA. Aedeagus as in Fig. 3. Female unknown.

BIONOMICS. Not known.

DERIVATIO NOMINIS. Dedicated to the collector of the species Zbyněk Kejval.

DIFFERENTIAL DIAGNOSIS. *Dermatohomoeus kejvali* sp. n. is similar to *D. wachteli* Daffner, 1986 by the pattern of microsculpture of dorsum. It differs by rounded sides of aedeagus before the tip and by the shape of endophallus (see Fig. 3 and Daffner 1986).

Dermatohomoeus rufus Daffner, 1988

Dermatohomoeus rufus Daffner, 1988: 805.

MATERIAL EXAMINED. 1 spec., S. India, Permaade; 24 spec., S. India, Kunchappanai; 25 spec., S. India, Kallar Valley. Deposited in CZS and CDB.

No found has been published till now except the type material. Specimens examined were collected in one of the type localities.

DISTRIBUTION. India.

***Dermatohomoeus brunneus* Daffner, 1988**

Dermatohomoeus brunneus Daffner, 1988: 802

MATERIAL EXAMINED. 16 spec., S. India, Kunchappanai. Deposited in CZS and CDB.

No found has been published till now since the original description.

DISTRIBUTION. India.

***Dermatohomoeus portevini* (Champion, 1923)**

Liocolenis portevini Champion, 1923: 51–52.

MATERIAL EXAMINED. 2 spec., S. India, Vallakadavu, 15 spec., S. India, Kunchappanai. Deposited in CZS and CDB.

DISTRIBUTION. India, Nepal, Borneo, Thailand, Vietnam, Japan.

***Dermatohomoeus silvaticus* (Hlisenkovský, 1972)**

Acanthodaprepus silvaticus Hlisenkovský, 1972: 136–137

MATERIAL EXAMINED. 1 spec., S. India, Kallar Valley. Deposited in CZS.

First record for India.

DISTRIBUTION. Sri Lanka, India.

***Colenisia besucheti* (Hlisenkovský, 1972)**

Acanthodaprepus besucheti Hlisenkovský, 1972: 139.

MATERIAL EXAMINED. 1 spec., S. India, Kallar Valley. Deposited in CZS.

New record for India.

DISTRIBUTION. Sri Lanka, India.

***Colenisia championi* (Portevin, 1937)**

Colenis championi Portevin, 1937: 32

MATERIAL EXAMINED. 2 spec., S. India, Vallakadavu. Deposited in CZS

DISTRIBUTION. India.

***Colenisia ivani* Daffner, 1991**

Colenisia ivani Daffner, 1991: 393–395.

MATERIAL EXAMINED. 3 spec., S. India, Kallar Valley. Deposited in CZS. No found has been published till now since the original description

DISTRIBUTION. India.

***Colenisia luteicornis* (Hlisenkovský, 1972)**

Acanthodiaprepus luteicornis Hlisenkovský, 1972: 140.

MATERIAL EXAMINED. 4 spec., Thailand bor., Chiang Dao env., 24.v.–4.iv.1995, M. Snížek lgt. Deposited in CZS.

First record for Thailand.

DISTRIBUTION. Sri Lanka, India, Thailand.

***Colenisia mussardiana* Daffner, 1991**

Colenisia mussardiana Daffner, 1991: 403–404.

MATERIAL EXAMINED. 35 spec., S. India, Vallakadavu; 45 spec., S. India, Permaade; 2 spec., S. India Kallar Valley. Deposited in CZS and CDB.

No found has been published till now except the type material. Specimens examined were collected in one of the type localities.

DISTRIBUTION. India.

***Colenisia punctatula* Daffner, 1991**

Colenisia punctatula Daffner, 1991: 401.

MATERIAL EXAMINED. 2 spec., S. India, Pathanamthitta; 20 spec., S. India, Kallar Valley. Deposited in CZS.

No fund has been published till now since the original description.

DISTRIBUTION. India.

***Colenisia macrophthalma* Daffner, 1991**

Colenisia macrophthalma Daffner, 1991: 395–396.

MATERIAL EXAMINED. 1 spec., S. India, Kallar Valley. Deposited in CZS.

No found has been published till now except the type material. Specimens examined were collected in one of the type localities.

DISTRIBUTION. India.

***Colenisia semistrigata* Daffner, 1991**

Colenisia semistrigata Daffner, 1991: 393.

MATERIAL EXAMINED. 1 spec., S. India, Kallar Valley. Deposited in CZS.

No found has been published till now except the type material. Specimens examined were collected in one of the type localities.

DISTRIBUTION. India.

***Pseudcolenis boukali* sp. n.**

TYPE MATERIAL. Holotype, male, S. India, Kerala, Cardamom Hills, 15 km SW Munnar, Kallar Valley, 6.–18.xii.1993, 10° 02' N 76° 58' E, Boukal D. & Kejval Z. lgt. Deposited in CZS. Length of body 2.1 mm, head 0.3 mm, pronotum 0.5 mm, clytra 1.3 mm, antenna 0.6 mm, width of head 0.6 mm, pronotum 1.2 mm, elytra 1.3 mm.

Yellowish-red, elytra toward apex and lateral sides darker, 1st to 4th antennal segments yellowish, 5th one infusate, 6th to 10th black, 11th one brown with lighter apex.

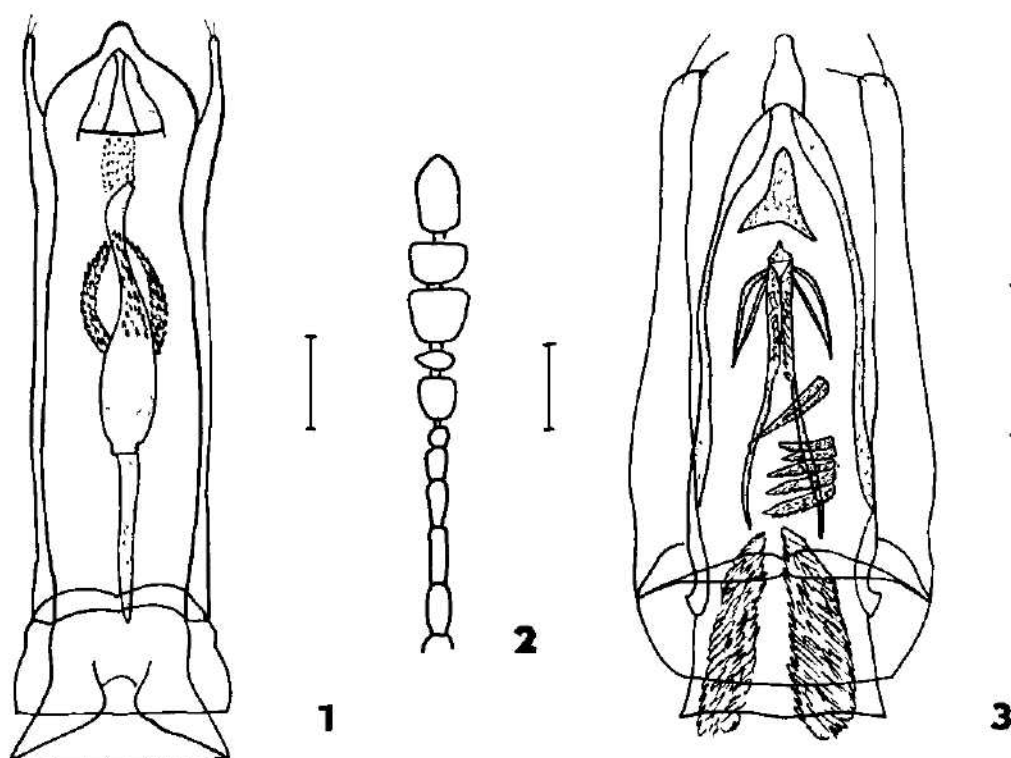
HEAD. Slightly, transversely strigose, finely, sparsely punctate, punctures separated by 4-5 times their diameter. Closely anteriorly before hind margin of eyes 4 large punctures arranged in transverse row. Eyes large, very convex. Antennae as in Fig. 2.

PRONOTUM. Strigose as on head. Punctures much smaller as those on head, spaced by 5-10 times their diameter. Punctuation scarcely visible. Rarely some larger punctures distributed. Hind angles widely rounded in dorsal view, rounded and slightly obtuse in lateral view. Basis finely emarginated before hind angles laterally seen.

ELYTRA. Very densely strigose, some minutiose, nearly invisible punctures bearing short fine setae rarely irregularly distributed in strigosites. Sutura raised, sutural striae reaching over 3 fifth of elytral length.

METASTERNUM. Membraneous wings fully developed. Legs. 1st to 3rd protarsal segments dilated. 1st segment nearly as long as the rest of tarsus.

GENITALIA. Aedeagus as in Fig. 1. Female unknown.



Figs 1-3 - 1, 2. *Pseudocolenis boukali* sp. n., 1 - aedeagus dorsally, 2 - antenna. - 3: *Dermatomoeus kejvali* sp. n., aedeagus dorsally Scale = 0.1 mm

DERIVATIO NOMINIS. Dedicated to David Boukal, collector of the species. Differential diagnosis: *Pseudocolenis boukali* sp. n. is similar to *P. rastrata* Champion, 1923 by the shape of body and by the microsculpture of dorsum. It differs by the 5th and following dark antennal segments. *P. rastrata* has dark antennae from the 6th segment. The shape of aedeagus is quite different in the both species (see Fig. 1 and in Daffner 1988b).

***Pseudocolenis haemisphaerica* (Champion, 1924)**

Pseudocolenis haemisphaerica Champion, 1924: 162

MATERIAL EXAMINED: 3 spec., S. India, Kunchappanai. Deposited in CZS.

DISTRIBUTION: India, Sri Lanka.

***Pseudocolenis loebli* Daffner, 1988**

Pseudocolenis loebli Daffner, 1988b: 167–168

MATERIAL EXAMINED: 3 spec., S. India, Vattur, 3 spec., S. India, St. Catherine Falls, 25 spec., S. India, Kunchappanai. Deposited in CZS and CDB.

DISTRIBUTION: India.

***Pseudocolenis strigosa* (Portevin, 1905)**

Liodynella strigosa Portevin, 1905: 423

MATERIAL EXAMINED: 2 spec., India, Himachal Pr., Manali, 2050 m, 25 iv 1998, 10 spec., NE Thailand, Doi Inthahon, 2500 m [above sea level], 25 iv 1991, S. Bilyigt. Deposited in CZS and coll. Bilyi.

First record for Thailand.

DISTRIBUTION: Nepal, India, Thailand.

APPENDIX

List of Leiodinae species known from India

Tribe Leiodini

<i>Leiodes</i> Latreille, 1802		
<i>L. atricolor</i> Champion, 1923	India, Nepal	Daffner, 1986: 81
<i>L. bengalica</i> Daffner, 1986	India	Daffner, 1986: 86
<i>L. besucheti</i> Daffner, 1986	India	Daffner, 1986: 84
<i>L. contracta</i> (Portevin, 1903)	India, Nepal	Daffner, 1986: 84
<i>L. loebli</i> Daffner, 1986	India	Daffner, 1986: 79
<i>L. major</i> (Portevin, 1926)	India, Pakistan	Daffner, 1983: 69
<i>Cyrtosoma</i> Daffner, 1982		
<i>C. bullata</i> Daffner, 1982	India	Daffner, 1982: 206
<i>C. foveola</i> Daffner, 1982	India	Daffner, 1982: 204
<i>Liocyrtusa</i> Daffner, 1982		
<i>L. mussardi</i> Daffner, 1982	India	Daffner, 1982: 209
<i>L. rotundata</i> (Champion, 1924)	India	Daffner, 1982: 209
<i>Cyrtusa</i> Erichson, 1841		
<i>C. gracilis</i> Daffner, 1982	India	Daffner, 1982: 211
<i>C. meghalayana</i> Daffner, 1985	India	Daffner, 1985: 117

<i>Zeadolopus</i> Broun, 1903.		
<i>Z. bengalicus</i> Daffner, 1983	India	Daffner, 1983: 606
<i>Z. besucheti</i> Daffner, 1983	India	Daffner, 1983: 607
<i>Z. fulvus</i> Daffner, 1983	India	Daffner, 1983: 611.
<i>Z. globus</i> Daffner, 1983	India	Daffner, 1983: 610
<i>Z. minimus</i> Daffner, 1983	India	Daffner, 1983: 609
<i>Z. multipunctatus</i> Daffner, 1983	India	Daffner, 1983: 612.
<i>Z. nanula</i> Daffner, 1982	India	Daffner, 1982: 216.
<i>Z. turgidum</i> Daffner, 1982	India	Daffner, 1982: 215

Tribe Pseudoliodini

<i>Dermatohomoeus</i> Hlissnikovský, 1963		
<i>D. besuchetianus</i> Daffner, 1988	India	Daffner, 1988a: 801.
<i>D. brunneus</i> Daffner, 1988	India	Daffner, 1988a: 802.
<i>D. garous</i> Daffner, 1988	India	Daffner, 1988a: 811.
<i>D. indicus</i> Daffner, 1988	India	Daffner, 1988a: 809.
<i>D. kejvali</i> sp. n.	India*	
<i>D. khasicus</i> Daffner, 1988	India	Daffner, 1988a: 813
<i>D. loeblianus</i> Daffner, 1988	India	Daffner, 1988a: 812.
<i>D. obscuratus</i> Daffner, 1988	India	Daffner, 1988a: 794
<i>D. portevin</i> (Champion, 1923)	India, Nepal, Borneo, Vietnam, Japan	Daffner, 1988a: 806.
<i>D. rufus</i> Daffner, 1988	India	Daffner, 1988a: 804.
<i>D. silvaticus</i> (Hlissnikovský, 1972)	Sri Lanka, India*	Daffner, 1988a: 804.
<i>D. strigellus</i> Daffner, 1988	India, Nepal	Daffner, 1988a: 797.
<i>Colenis</i> Erichson, 1841		
<i>C. estriata</i> (Champion, 1923)	India	Hatch, 1929: 47.
<i>Allocolenia</i> Daffner, 1990.		
<i>A. semistriata</i> Daffner, 1992	India, Thailand	Daffner, 1992: 1008.
<i>Colemsia</i> Fauvel, 1902.		
<i>C. besucheti</i> (Hlissnikovský, 1972)	Sri Lanka, India*	Daffner, 1991: 404
<i>C. curticornis</i> Daffner, 1991	India	Daffner, 1991: 400
<i>C. championi</i> (Portevin, 1937)	India	Daffner, 1991: 404
<i>C. ivani</i> Daffner, 1991	India	Daffner, 1991: 393
<i>C. luteicornis</i> (Hlissnikovský, 1972)	Sri Lanka, India, Thailand*	Daffner, 1991: 402
<i>C. macrophthalma</i> Daffner, 1991	India	Daffner, 1991: 395
<i>C. mussardiana</i> Daffner, 1991	India	Daffner, 1991: 403
<i>C. polita</i> Daffner, 1991	India	Daffner, 1991: 391.
<i>C. punctatula</i> Daffner, 1991	India	Daffner, 1991: 401
<i>C. semistriata</i> Daffner, 1991	India	Daffner, 1991: 393.
<i>Pseudocolenis</i> Reitter, 1884.		
<i>P. aciculata</i> Daffner, 1988	India	Daffner, 1988b: 175.
<i>P. besucheti</i> Daffner, 1988	India	Daffner, 1988b: 174
<i>P. boukali</i> sp. n.	India*	
<i>P. bouvieri</i> (Portevin, 1903)	India, China	Angelini & Švec, 1994: 29.
<i>P. disparilis</i> (Champion, 1924)	India, Nepal	Daffner, 1988b: 176.
<i>P. flavicollis</i> Daffner, 1988	India	Daffner, 1988b: 165.
<i>P. haemisphaerica</i> (Champion, 1924)	India, Sri Lanka	Daffner, 1988b: 163.
<i>P. indica</i> (Portevin, 1926)	India	Daffner, 1988b: 170.
<i>P. loebli</i> Daffner, 1988	India	Daffner, 1988b: 167.
<i>P. rastratu</i> (Champion, 1923)	India	Daffner, 1988b: 162.
<i>P. strigosa</i> (Portevin, 1905)	India, Thailand*	Daffner, 1988b: 163.
<i>P. varicornis</i> (Champion, 1924)	India	Daffner, 1988b: 163.

Remark: The species signed by * are added to the region newly.

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Eriophyid mites (Acari: Eriophyoidea) on trees and shrubs in the Czech Republic

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Abstract Ninety eriophyid mite species causing galls on trees and shrubs were recorded in the Czech Republic during 1910–1969 and fifty species during 1978–1986. Population density of eriophyid mite species changes in long-term intervals. *Eriophyes platanoideus* (Nalepa, 1922) on *Acer pseudoplatanus*, *Vasates hippocastani* Focke, 1890 on *Aesculus hippocastani*, *Eriophyes convolvens* (Nalepa, 1892) on *Euonymus europaeus*, *Cecidophyopsis ribis* (Westwood, 1869) on *Ribes grossularia*, *Phytoptus loewi* (Nalepa, 1890) on *Syringa vulgaris* and *Colomerus vitis* (Pagenstecher, 1859) on *Vitis vinifera* belong to disappearing species. Thirty seven eriophyid mite species were found at twelve localities of the city Praha. The occurrence, frequency and plant-animal relations are discussed.

Faunistics, gall-causing species, population density, occurrence, frequency, host plant-animal relations, Acari, Eriophyoidea, Palaearctic Region

INTRODUCTION

Eriophyid mites, forming the superfamily Eriophyoidea, are till present rather neglected group of organisms although results of their action, the galls, may be abundantly observed on various plants, shrubs and trees. Eriophyid mites are difficult to observe because their body is exceedingly small, often less than 0,1 mm. They have a soft, wormlike body with two body regions, the gnathosoma including mouthparts, and the idiosoma including the remainder part of the body. Eriophyid mites are unique among the mites because they have only two pairs of forward oriented legs. They are blind, without respiratory and circulatory systems both of which are results of their parasitic life inside the plant tissues. The mouthparts are adapted for sucking liquid food from plant tissues.

All eriophyid mites are parasites adapted to live on or in plants. Some eriophyid mites induce the development of new forms on various plant organs, commonly named as „galls“ (in Latin „*cecidium*“). The galls induced by eriophyid mites are usually called acarocecidia. Eriophyid mites cause galls on various herbaceous plants, on shrubs and trees. Some of them are serious pests on agricultural plants. Many eriophyid mite species develop also on trees, sometimes in such numbers that they may be designated as pests of forest trees. Several eriophyid mites may be vectors in transmission of plant viruses. Ornamental trees and shrubs in cities and towns are frequently be damaged by eriophyid mites. Trees and shrubs may be damaged mainly by the reducing and precocious fall off of leaves from trees injured by eriophyid mites.

Some eriophyid mite species live as guests in galls caused by other eriophyid mites (so called inquiline) and some species may live free on plants moving on the surface of various trees and shrubs (so called vagrants). Sometimes it is not quite clear which eriophyid mite is a gall-causer and which species live as inquiline inside gall together with the gall-causer.

During 1978–1986 I collected eriophyid galls on trees and shrubs in the territory of the Czech Republic and evaluated the previous data about occurrence of these mites which were gathered by earlier researchers. A special attention was given to the fauna of eriophyid mites of the territory of the city Praha where I investigated also the development of galls of several mites on their host plants in the course of one vegetation season.

Present work is the first summary elaboration dealing with species of the superfamily Eriophyoidea from the territory of the Czech Republic.

HISTORY

The beginnings of the study of eriophyid mites in Europe are connected with the name of the French natural historian R. A. F. Réaumur. In 1737 he was the first called attention to the mite galls, called at that time as „erineum“, in his book „Histoire naturelle..“ (Réaumur 1737).

First genera and species of eriophyid mites were described in the middle of the nineteenth century, viz. the genus *Eriophyes* by Siebold (1850), and the genus *Phytoptus* by Dujardin (1851). Pagenstecher (1859), Frauenfeld (1865) and Donnadieu (1875) described several new eriophyid species from various part of Europe. Canestrini (1890, 1891), Canestrini and Massalongo (1893) and Massalongo (1891) gave descriptions of several new eriophyid species from the territory of Italy.

The Austrian entomologist A. Nalepa may be designated as the founder and pioneer of the studies of eriophyid mites in Europe. He occupied with eriophyid mites from various points of view and studied their morphology, anatomy, systematics and also biology. He elaborated methods for collecting galls, methods of preservation of galls in collections and also methods of mounting of eriophyid mites into permanent microscope slides.

In the period 1886–1930 Nalepa published more than 30 papers with descriptions of eriophyid mites. At the beginning of his career he studied the anatomy (Nalepa 1887) and life cycles of several eriophyid species (Nalepa 1894). Descriptions of 101 eriophyid species are included in his fundamental work (Nalepa 1911).

Nalepa (1911) in his comprehensive book expressed his four postulates which referred to the descriptions of new eriophyid species and subspecies in relation to their host plant, as follows:

1. Galls, which are similar in the structure and occur on not-related host plant species, are caused by various species of eriophyid mites.
2. Galls, which are similar in the structure and occur on closely related host plant species and genera, may be caused by the same eriophyes species or at least by the subspecies of such eriophyid mite species.
3. Galls, which are different in the structure and occur on the same host plant species, are caused by various species of eriophyid mites.
4. Galls, which are different in the structure and occur on not-related host plant species and genera, are caused by various species of eriophyid mites.

The consistent application of the second item of Nalepa's postulate produced considerable disorder and subsequently production of large number of subspecific names of eriophyid mites (trinomial names). This approach to nomenclature of eriophyid mites has been later revalued and the binomial names has been started to use. The majority of subspecific eriophyid names was transferred in the category of specific names.

Nalepa (1929) summarized his knowledge about eriophyid mites in his comprehensive paper.

Very important for subsequent development and progress in many-sided studies of eriophyid mites as a part of cecidological studies was the foundation of the journal „Marcellia“ at the

beginning of the 20th century. The Italian entomologist A. Trotter founded this journal in 1902 in honour of the Italian scientist Marcello Malpighi (1628–1694) and devoted it to the cecidological problems. It was published in Italy, 1958–1972 at Strasbourg (France) and 1974–1977 at Oxford (England). In 1980 this journal was combined with the journal „Cecidologia Indica“ to form the journal „Cecidologia Internationale“ which is published in Allahabad (India) till present.

The second very important moment, stimulating cecidological studies in all European countries and also in North Africa, was the edition of two-volume comprehensive book of Houard (1908–1909) with keys for determination of galls caused by cecidogenous animals (called cecidozoa) known at that time from Europe and Mediterranean area.

In Germany H. Ross who worked as a conservator at the Botanical Museum in Munich (München) published in 1911 a comprehensive book dealing with galls of middle and northern Europe. He summarized the up-to-date knowledge about galls and their causers and gave keys for determination of galls according to their host plants (Ross 1911, Ross and Hedicke 1927). Later Buhr (1964–1965) published two-volume book including the identification keys which are arranged according to host plant genera. This book assist to identify the eriophyid mite galls and to distinguish eriophyid injury from similar symptoms caused by other organisms.

Schlechtendal (1916) published the comprehensive work dealing with galls of eriophyid mites occurring on herbaceous plants, shrubs and trees in central Europe.

Postner (1968, 1976) contributed to the systematics and biology of eriophyid mites developing on *Abies alba* in Europe and described one new species, *Trisetacus abietis*.

Several entomologists contributed to the development of knowledge about eriophyid mites in Europe. Vitzthum (1929, 1940) summarized scattered informations about eriophyid mites and elaborated keys for identification of mites and their classification (system). Liro (1940) described several new eriophyid mite species from the territory of Finland. Roivainen (1953) published a review of subfamilies of European eriophyid mites. Farkas (1965) evaluated the eriophyid mites as a family Eriophyidae including seven subfamilies and gave the keys for identification of genera and species of eriophyid mites.

In France Meyer and Maresquille (1983) in their fundamental work „Anatomie des Galles“ included a review of past and recent findings and also of new theories in cecidology. They gave besides others a detailed descriptions of structures of galls caused by 45 eriophyid mite species. Since 1970 Westphal studied the ultrastructure, cytology and histochemistry of several eriophyid mites which form galls on *Ulmus*, *Tilia* and *Prunus padus*. She published her main results in a comprehensive paper (Westphal 1977a).

In Italy the acarologist Nuzzaci (1976a, b) investigated internal structures, viz. musculature, digestive and sexual organs) of several eriophyid mites using the electron transmitting and rastering microscope technique. He studied also the problems of agricultural acarology, mainly eriophyid mites which are serious pests of olive trees in Italy (Nuzzaci & Parenzan 1983).

In Poland several researchers studied complex of insects and mites associated with agricultural crops (Boczek 1970, Boczek & Chyczewski 1975, Lipa et al. 1977). Boczek (1966) published a key for determination of genera of Eriophyoidea and since that time till present he described many new species of eriophyid mites from Poland and from other European countries (Boczek et Petanovic 1994). Boczek (1970) published a review of eriophyid mites which occurred on trees in orchards in Poland, studied the biology and life cycles of Eriophyes piri developing on pear (Boczek & Szewczyk 1970), on grasses (Boczek & Chyczewski 1975). The occurrence of eriophyid mites in apple and plum orchards in Poland was investigated by Kozłowski (1979).

In Russia Shevtschenko (1957, 1974) contributed to the development of eriophyid studies by descriptions of several new species from the Asian part of his country and also to the taxonomy of the group. In Armenia Bagdasarian (1976) studied eriophyid mites which damage fruits of subtropical plants.

In Denmark Thomsen (1975, 1976) studied development and histology of galls on the leaves of *Tilia platyphyllos* caused by *Eriophyes tiliae tiliae* and also its morphology and life cycle.

In India M. S. Mani, professor of zoology and entomology of the School of Entomology, St. John's College, Agra, may be designated as a founder of cecidological studies in Asian subcontinent. He gave in his paper (Mani 1959) a comprehensive account of the plant galls, produced by insects, mites, nematodes, fungi and bacteria, so far known from India. Later Mani (1964) in his book „Ecology of plant galls“ summarized and generalized the knowledge about this topic together with review of literature. Mani (1973) published a compendium about galls in India and gave the keys for identification of galls on Indian plants.

Mani initiated the study of cecidological problems in India and founded the Indian cecidological school. In 1966 scientific activities of Indian researchers led to the establishment of scientific journal „Cecidologia Indica“ which importantly contributed to the development of cecidological studies in India.

In North America a group of acarologists contributed to the knowledge of eriophyid mites mainly by descriptions of new taxa from this area and also by studies dealing with eriophyid biology and importance as pests of agricultural plants (Keifer 1964, Jeppson et al. 1975; Keifer et al. 1982). They turned attention to the problem of classification of eriophyid mites. Baker and Wharton (1952), giving diagnoses of 45 genera of eriophyid mites, separated the family Eriophyidae into four subfamilies, viz. Phytoptinae, Sierraphytoptinae, Eriophyinae and Phyllocoptinae. Later Keifer et al. (1982) evaluated eriophyid mites as the superfamily Eriophyoidea in which they included three independent families, viz. Eriophyidae, Phytoptidae and Rhyncaphytoptidae, and summarized the knowledge about eriophyid mites causing galls and other abnormalities in North-America.

Ridland and Halloran (1979, 1980a, b, c, 1981) studied the biology and harmfulness of *Eriophyes medicaginis*, a serious pest of lucerne (alfalfa) and clover in North America. Smith (1984) revised the eriophyid mites developing on coniferous trees in North America.

Davis et al. (1982) published a review of eriophyid mites of the world, both phytophagous causing galls on host plants and also free living eriophyids. This catalogue includes 1859 species of eriophyid mites assigned to 156 genera.

The present stage of knowledge dealing with eriophyid mites is brought together in books of Ananthakrishnan (1984) and of Shorthouse & Rohfritsch (1992).

In the Czech Republic three entomologists and phytopathologists contributed substantially to the knowledge about occurrence of galls caused by eriophyid mites on various host plant in the territory of the Czech Republic within frame-works of their zoocecidological investigations.

Bayer published during the period 1910–1946 seven papers about occurrence of galls caused by various animals (so called zoocecidia), including also eriophyid mites, in the territory of Bohemia and Moravia (two historical parts of the Czech Republic).

Baudyš published forty five contributions dealing with occurrence of galls caused by various animals in the territory of Bohemia, Moravia and Silesia, during period 1912–1969. Baudyš (1954a) in his most important paper about occurrence of galls in the northeast part of Moravia and Silesia brought 93 gall causing eriophyid mite species which cause galls on 71 host plant trees species.

Černík (1925–1942) contributed in his 16 papers to the knowledge of gall causing eriophyid mites which he investigated in the surroundings of the town Olomouc in the northern part of Moravia

The Czech cytologist B. Němec (1916, 1917a, b, 1921, 1924) published the pioneer studies of microscopical structure of several eriophyid galls. Also the Czech botanist Klika (1923) contributed to the development of cecidology by his histological studies of galls of several eriophyid mites

The Czech forest zoologist Pfeffer (1954) brought in his book „Forest Zoology“ a review of eriophyid mite species which caused galls on coniferous and deciduous forest trees

Blatný et al. (1956) gave descriptions of symptoms and injuries caused by nine eriophyid mite species on various fruit trees and shrubs

The Polish entomologist J. Boczek was invited to write a chapter dealing with eriophyid mites for the 4th volume of the book-series „Key to the Fauna of the Czechoslovakia“ (Klíč zvířeny ČSSR, 1971). He anticipated in his contribution that representatives of 33 genera of the eriophyid mites may occur in the territory of the former Czechoslovakia (Boczek 1971)

MATERIAL AND METHODS

Galls of eriophyid mites on host plants were collected at 75 localities of the Czech Republic during period of 1976–1986 (Fig. 1). Localities were not dislocated regularly (evenly) over the territory of the Czech Republic because they were mainly the places of my short-lasting stays during the summer holidays. At each locality I used the method of the time-collecting, i.e. I searched for eriophyid galls on host plants during the time long about one hour. At each locality all eriophyid species were recorded into the notebook to obtain data about their frequency and abundance.

The host plants with eriophyid galls were usually elaborated in the following way. I put each eriophyid species with its host plant between two filter papers (blotting papers) to press and to dry. Later I transferred each host plant with eriophyid galls in the white herbarium paper, fixed to the paper and wrote the needed data, i.e. the name of the eriophyid species, the name of the host plant species, the name of the locality and the date of collecting.

The second part of collected plants with eriophyid galls I put into small glasses with 75% alcohol for subsequent morphological studies of eriophyid mites and for histological studies of eriophyid galls on their host plants.

During the period of 1978–1986 I carried out intensive investigations at several selected localities laying in the territory of the city Praha and its surroundings (Fig. 2). I collected there eriophyid galls also by the method of the time-collecting but with more longer interval, during two up to three hours. Eriophyid galls were collected mainly in larger parks in the centre of the city and in the parks laying in the periphery and surroundings of Praha. Eriophyid galls gathered during these studies are deposited in the collection of galls of M. Skuhrava, Praha.

LOCALITIES EXAMINED

The dislocation of localities examined is given in the Fig. 1 and short characterizations in the following part. Before the name of a locality it is given a number which corresponds to the number in the Table 2 (above), after the name of a locality is given its altitude and abbreviations of the higher territorial unit in which it belongs: e B – eastern Bohemia, m B – middle Bohemia, n B – northern Bohemia, s B – southern Bohemia, w B – western Bohemia, n M – northern Moravia, s M – southern Moravia.

1 Pernštejn, 430 m a s l, s M 2 Doubravnik, 323 m a s l, s M 3 Tišnov near Brno, 256 m a s l, s M 4 Veverska Bítýška, 430 m a s l, s M 5 Neslovice, 338 m a s l, s M 6 Radostice, 284 m a s l, s M 7 Proseč, 530 m a s l, s M 8 Borova near Polička, 595 m a s l, e B 9 Jedlova near Polička, 650 m a s l, e B 10 Hamry near Bystrý, 593 m a s l, e B 11 Vír near Žďár nad Sázavou, 430 m a s l, s M 12 Koclířov, 502 m a s l, e B 13 Studená Loučka, 532 m a s l, n M 14 Mladeč near Litovle, 242 m a s l, n M 15 Heřtšejn, 233 m a s l, n M 16 Ustí nad Bočvou, 257 m a s l, n M 17 Zašova, 348 m a s l, n M 18 Kněhyně, 550 m a s l, n M 19 Kunčice pod Ondřejníkem, 395 m a s l, n M 20 Leskovec, 512 m a s l, n M 21 Vrančá, 453 m a s l, n M 22 Huslenky, 390 m a s l, n M 23 Semetín, 410 m a s l, n M 24 Hodslavice, 337 m a s l, n M 25 Nový Jičín, 286 m a s l, n M 26 Hukvaldy, 357 m a s l, n M 27 Dobruška near Frydek-Místek, 332 m a s l, n M 28 Řeka near Smilovice, 485 m a s l, n M 29 Kani near Frenštát pod Radhoštěm, 680 m a s l, n M 30 Troják, 650 m a s l, s M 31 Kašava, 334 m a s l, s M 32 Fryšták, 271 m a s l, s M 33 Přelpey, 297 m a s l, s M 34

Luleč, 302 m a. s. l., s. M. 35 Albrechtice in the Jizerské hory Mts., 610 m a. s. l., n. B. 36 Voltuš near Příbram, 607 m a. s. l., m. B. 37 Vysoká near Příbram, 575 m a. s. l., m. B. 38 Třemšín, 827 m a. s. l., in the Brdská vrchovina Highlands, m. B. 39 Březnice, 424 m a. s. l., m. B. 40 Jelení vrchy, 845 m a. s. l., in the Šumava Mts., s. B. 41 Písek, 370 m a. s. l., s. B. 42 Domanín, 563 m a. s. l., s. M. 43 Štěpánov nad Svratkou, 346 m a. s. l., s. M. 44 Kunštát, 445 m a. s. l., s. M. 45 Boskovice, 381 m a. s. l., s. M. 46 Holštejn, 462 m a. s. l., s. M. 47 Chvalkovice, 337 m a. s. l., s. M. 48 Morkovice, 300 m a. s. l., s. M. 49 Zdounky, 237 m a. s. l., s. M. 50 Chropyně, 195 m a. s. l., s. M. 51 Troubky, 268 m a. s. l., s. M. 52 Čechy pod Kosířem, 275 m a. s. l., s. M. 53 Brodek near Prostějov, 260 m a. s. l., s. M. 54 Lednice, 173 m a. s. l., s. M. 55 Oslavička, 510 m a. s. l., s. M. 56 Sádek near Třebíč, 510 m a. s. l., s. M. 57 Dalešice, 398 m a. s. l., s. M. 58 Krahulov, 467 m a. s. l., s. M. 59 Luka nad Jihlavou, 442 m a. s. l., s. M. 60 Bítovány, 593 m a. s. l., s. M. 61 Kamenice, 510 m a. s. l., s. M. 62 Nová Ráby, 370 m a. s. l., m. B. 63 Dobříš, 371 m a. s. l., m. B. 64 Losiny, 400 m a. s. l., m. B. 65 Špindlerův Mlýn, 850 m a. s. l., in the Krkonoše Mts., c. B. 66 Františkova Ves near Sušice, 525 m a. s. l., w. B. 67 Mouřenec, 600 m a. s. l., w. B. 68 Hory Matky Boží, 675 m a. s. l., w. B. 69 Velhartice, 622 m a. s. l., w. B. 70 Svatobor near Sušice, 840 m a. s. l., w. B. 71 Zámyšl near Hlavňovice, 782 m a. s. l., w. B. 72 Špičák, 1202 m a. s. l., in the Šumava Mts., w. B. 73 Kašperk, 758 m a. s. l., w. B. 74 Týřezerní slat, 900 m a. s. l., in the Šumava Mts., w. B. 75 Vydra near Modrava, 900 m a. s. l., w. B.

RESULTS

Occurrence of eriophyid mite species on trees and shrubs in the Czech Republic

Occurrence in the 20th century

From the beginning of the 20th century 90 eriophyid mite species were recorded on trees and shrubs in the territory of the Czech Republic based on data about occurrence gathered by Bayer, Baudyš and Černík and on data obtained during my own investigations in 1978–1986. Bayer (1910–1946) recorded occurrence of 58, Černík (1925–1942) 38 and Baudyš (1912–1969) 88 eriophyid mite species (Table 1).

During the period of 1978–1986 I recorded the occurrence of 50 eriophyid mite species, developing and causing galls on 26 host plant species, at 75 localities in the territory of the Czech Republic (Table 2).

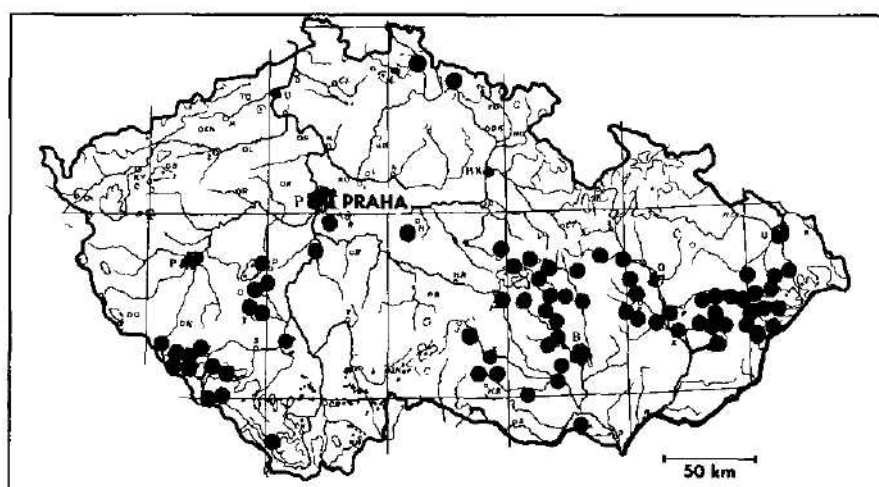


Fig. 1 The territory of the Czech Republic with localities (black circles) where the investigations of the occurrence of eriophyid mite species was carried out during 1978–1986.

Tab 1 List of eriophyid mite species recorded on trees and shrubs in the Czech Republic during period 1910–1986. Names of collectors: Bš Baudyš, By Bayer, Čc Černík, Va Vaněčková-Skuhravá

Host plant species	Eriophyid species	Symptom of injury	Collectors			
			Bš	By	Čc	Va
<i>Abies alba</i>	<i>Trisetacus floricolus</i>	atrophied inflorescence	+			
<i>Acer</i>	<i>Eriophyes macrochelus</i>	axil galls	+	+		+
	<i>Ariacris macrorhynchus</i>	leaf galls	+	+		+
	<i>Aculops aceris</i>	erineum	+	+		+
	<i>Eriophyes acericola</i>	leaf galls				+
	<i>Eriophyes platanoides</i>	erineum	+	+		
	<i>Eriophyes pseudoplatani</i>	erineum	+	+	+	+
	<i>Eriophyes eriobius</i>	erineum	+	+		+
	<i>Aceria crassipunctata</i>	erineum	+			+
	<i>Eriophyes vermicularis</i>	swollen bud	+			+
	<i>Eriophyes heteronyx</i>	bark galls	+			
	<i>Eriophyes heteronyx</i>	erineum	+			
	<i>Copitophylla gymnaspsis</i>	erineum	+			
<i>Aesculus hippocastanum</i>	<i>Vasates hippocastani</i>	erineum	+	+	+	+
<i>Alnus glutinosa</i> & <i>A. incana</i>	<i>Phytoptus laevis</i>	leaf galls	+	+	+	+
	<i>Eriophyes longirostris</i>	young leaf	+			
	<i>Acaphylla trinotus</i>	leaf galls	+	+		+
	<i>Eriophyes unangulis</i>	leaf galls	+	+	+	+
	<i>Acalitus brevitarsus</i>	erineum	+	+	+	+
<i>Betula</i>	<i>Cecidophyes betulae</i>	leaf galls	+	+		
	<i>Phyllocoptes lonotus</i>	erineum	+	+		
	<i>Eriophyes longisetosus</i>	erineum	+	+	+	+
	<i>Acalitus rudis</i>	erineum	+	+	+	+
	<i>Eriophyes calycophthirus</i>	bud galls	+	+	+	+
<i>Carpinus betulus</i>	<i>Eriophyes macrotrichus</i>	leaf furrowing	+	+	+	+
	<i>Eriophyes tenellus</i>	erineum	+	+	+	+
<i>Corylus avellana</i>	<i>Phytocoptella avellanae</i>	big bud galls	+	+	+	+
	<i>Cecidophyopsis vermiformis</i>	deformed young shoot	+		+	
<i>Cotoneaster interregima</i>	<i>Acalitus phloeocoptes</i>	bark and bud galls	+	+		
	<i>Phytoptus pyri</i>	leaf pustules	+			
<i>Crataegus oxyacantha</i>	<i>Phyllocoptes goniothorax</i>	rolled leaf margin	+	+		+
	<i>Eriophyes crataegumplicans</i>	wrinkled leaf	+			
	<i>Eriophyes crataegi</i>	leaf galls	+			
	<i>Eriophyes calycobius</i>	swollen bud	+			+
<i>Euonymus europaeus</i>	<i>Eriophyes convolvens</i>	rolled leaf margin	+	+		+
	<i>Cecidophyes psilonotus</i>	erineum	+			+
<i>Fagus sylvatica</i>	<i>Aceria plicans</i>	wrinkled leaf	+		+	+
	<i>Aceria stenaspis</i>	rolled leaf margin	+	+	+	+
	<i>Eriophyes nervisequus</i>	erineum	+	+		+
	<i>Aceria blastophthra</i>	swollen buds	+			
<i>Fraxinus excelsior</i>	<i>Aculus epiphyllus</i>	leaf galls	+		+	
	<i>Eriophyes fraxinicola</i>	leaf galls	+		+	+
	<i>Phyllocoptes fraxini</i>	rolled leaf margin				+
	<i>Eriophyes fraxinivorus</i>	deformed inflorescences	+	+	+	+
<i>Juglans regia</i>	<i>Eriophyes tristriatus</i>	leaf galls	+	+		+
	<i>Eriophyes erineus</i>	erineum	+	+	+	+
<i>Juniperus communis</i>	<i>Trisetacus juniperinus</i>	swollen needles at top	+			
<i>Larix decidua</i>	<i>Trisetacus pini</i>	swollen bud	+			+
<i>Lonicera xylosteum</i>	<i>Phyllocoptes xylostei</i>	rolled leaf margin	+	+		
<i>Malus sylvestris</i>	<i>Phyllocoptes goniothorax</i>	rolled leaf margin	+	+		
	<i>Phyllocoptes mali</i>	pouch leaf galls	+	+	+	

Tab 1 (continued)

Host plantspecies	Enophyid species	Symptom of injury	Collectors			
			Bs	By	Če	Va
<i>Ostrya carpinifolia</i>	<i>Eriophyes macrotrichus</i>	folded lateral veins	+			+
<i>Pinus sylvestris</i>	<i>Trisetacus pini</i>	bark galls	+	+	+	+
<i>Populus tremula</i>	<i>Eriophyes diversipunctatus</i>	swollen veins	+	+	+	+
	<i>Aculus dispar</i>	rolled leaf margin	+	+	+	
	<i>Aceria vera</i>	crinenum	+	+	+	+
	<i>Phyllocoptes populi</i>	simple galls	+	+		+
	<i>Eriophyes populi</i>	bud galls	+	+	+	
<i>Prunus</i>	<i>Phytoptus similis</i>	leaf margin galls	+	+		+
	<i>Phytoptus padi</i>	leaf galls	+	+	+	+
	<i>Acalitus phloeocoptes</i>	bud galls	+	+		
	<i>Eriophyes paderinensis</i>	crinenum	+	+	+	+
<i>Pyrus communis</i>	<i>Phytoptus marginemtorquens</i>	rolled leaf margin	+			
	<i>Epitrimerus pyri</i>	rust	+	+	+	+
	<i>Phytoptus pyri</i>	leaf pustules	+	+	+	+
<i>Quercus petraea</i>	<i>Eriophyes quercinus</i>	crinenum	+	+		
<i>Rhamnus cathartica</i>	<i>Aceria annuata</i>	crinenum	+	+		
<i>Ribes</i>	<i>Cecidophyopsis ribis</i>	bud galls	+			
	<i>Aceria scaber</i>	leaf swelling	+			
<i>Robinia pseudoacacia</i>	<i>Vasates robiniae</i>	leaf deformation	+			
<i>Rubus</i>	<i>Phyllocoptes gracilis</i>	deformed leaves	+			
	<i>Eriophyes rubicolens</i>	crinenum	+			
	<i>Phyllocoptes gibbosus</i>	bud galls	+	+		
<i>Salix</i>	<i>Aculops tetanotrix</i>	leaf galls	+	+	+	+
	<i>Stenacis irradiatus</i>	large bud deformation	+	+		+
	<i>Aceria salicina</i>	large bud deformation	+	+		
	<i>Phyllocoptes phytoptoides</i>	large bud galls	+			
	<i>Vasates phyllocoptoides</i>	large bud galls	+			
	<i>Acaphylla salicobius</i>	rolled leaf margin		+		
	<i>Phyllocoptes magnirostris</i>	rolled leaf margin	+			+
	<i>Aceria gemmarum</i>	bud gall	+			+
	<i>Aculus truncatus</i>	leaf margin galls	+	+	+	
<i>Sambucus nigra</i>	<i>Epitrimerus trilobus</i>	rolled leaf margin	+	+	+	+
<i>Sorbus sorbeus</i>	<i>Eriophyes sorbeus</i>	crinenum	+			+
	<i>Phytoptus sorbi</i>	crinenum	+	+	+	+
<i>Syringa vulgaris</i>	<i>Phytoptus loewi</i>	deformed buds	+	+	+	
<i>Taxus baccata</i>	<i>Cecidophyopsis psilaspis</i>	bud galls	+			+
<i>Tilia</i>	<i>Phytoptus tiliae</i>	leaf galls	+	+	+	+
	<i>Aceria exilis</i>	axil galls	+	+	+	+
	<i>Phytocoptella tetratrichus</i>	rolled leaf margin	+	+	+	+
	<i>Eriophyes lisosoma</i>	crinenum	+	+	+	+
	<i>Aceria exilis</i>	crinenum	+	+	+	+
<i>Ulmus</i>	<i>Aculus brevipunctatus</i>	pouch galls	+	+	+	+
	<i>Aculus ulmicola</i>	leaf galls	+	+		+
	<i>Eriophyes filiformis</i>	leaf galls	+	+	+	
<i>Viburnum lantana</i>	<i>Eriophyes viburni</i>	pouch galls	+	+		
<i>Vitis vinifera</i>	<i>Colomerus vitis</i>	crinenum	+	+		

Tab 3 The most abundant eriophyid mite species which occurred in the Czech Republic during period 1910–1969 (based on number of citations)

Eriophyid mite species	Host plant species	Total citations during 1910–1969
<i>Phytoptus padi</i>	<i>Prunus padus</i> <i>P. spinosa</i>	45
<i>Artacris macrorhynchus</i>	<i>Acer pseudoplatanus</i> , <i>Acer campestre</i>	37
<i>Phytoptus tiliae</i>	<i>Tilia platyphyllos</i> <i>Tilia cordata</i>	33
<i>Acalitus brevitarsus</i>	<i>Alnus glutinosa</i>	31
<i>Aculops tetanothrix</i>	<i>Salix aurita</i> and other species	31
<i>Phytoptus similis</i>	<i>Prunus domestica</i> <i>Prunus spinosa</i>	31
<i>Phytoptus laevis</i>	<i>Alnus glutinosa</i>	26
<i>Phyllocoptes goniothorax</i>	<i>Malus sylvestris</i>	25
<i>Eptimerus trilobus</i>	<i>Sambucus nigra</i>	24
<i>Aceria exilis</i>	<i>Tilia platyphyllos</i> <i>Tilia cordata</i>	22
<i>Eriophyes lisoma</i>	<i>Tilia platyphyllos</i> <i>Tilia cordata</i>	22
<i>Phytocoptella tetratrichus</i>	<i>Tilia cordata</i> <i>Tilia platyphyllos</i>	20
<i>Stenacis triradiatus</i>	<i>Salix</i> various species	20
<i>Eriophyes pseudoplatani</i>	<i>Acer pseudoplatanus</i>	19
<i>Phyllocoptes populi</i>	<i>Populus tremula</i>	19

Based on the comparison of data about occurrence of eriophyid mite species gathered by earlier authors in the first half of the 20th century (shown in number of citations) with my own records obtained in the last quarter of the 20th century it may be concluded that the species composition of eriophyid mites has changed. Many species, which occurred abundantly at many localities in the past, are rare at present. Occurrence of several eriophyid species, which were rare in the past, rose expressively, some of them belong now to the commonly occurring eriophyid species (see Table 3 and 4)

Tab 4 The most abundant eriophyid mite species in the Czech Republic found during faunal investigations 1976–1986

Eriophyid mite species	Host plant species	Number of findings
<i>Artacris macrorhynchus</i>	<i>Acer pseudoplatanus</i>	34
<i>Phytoptus laevis</i>	<i>Alnus glutinosa</i>	19
<i>Phytoptus tiliae</i>	<i>Tilia platyphyllos</i> <i>Tilia cordata</i>	18
<i>Phyllocoptes populi</i>	<i>Populus tremula</i>	18
<i>Eriophyes lisoma</i>	<i>Tilia cordata</i>	16
<i>Eriophyes pseudoplatani</i>	<i>Acer pseudoplatanus</i>	15
<i>Aculops tetanothrix</i>	<i>Salix caprea</i>	12
<i>Phytoptus similis</i>	<i>Prunus spinosa</i> <i>Prunus domestica</i>	11
<i>Eptimerus trilobus</i>	<i>Sambucus nigra</i>	11
<i>Eriophyes inangulis</i>	<i>Alnus glutinosa</i>	10
<i>Aceria exilis</i>	<i>Tilia platyphyllos</i> , <i>Tilia cordata</i>	9
<i>Acalitus brevitarsus</i>	<i>Alnus glutinosa</i>	9
<i>Aceria varia</i>	<i>Populus tremula</i>	8
<i>Eriophyes sorbeus</i>	<i>Sorbus aucuparia</i>	8
<i>Phytocoptella tetratrichus</i>	<i>Tilia cordata</i> <i>T. platyphyllos</i>	8

Tab 2 List of eriophyid mite species recorded on trees and shrubs in the Czech Republic during investigations 1978-1986

Host plant species	Endopterygota species	Localities	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
Host plant species	Endopterygota species	Localities	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
Host plant species	Endopterygota species	Localities	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100

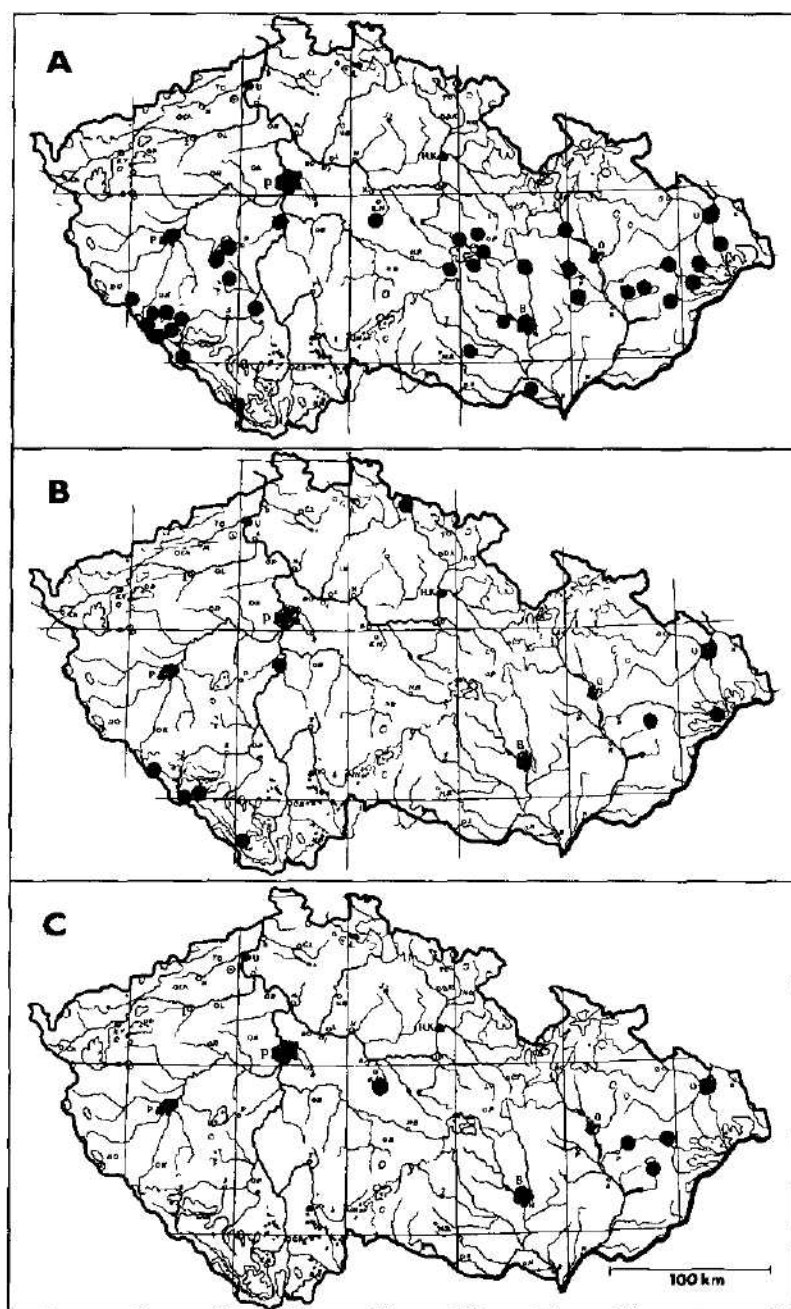


Fig. 2 The occurrence of eriophyid mite species in the territory of the Czech Republic. A – *Artacris macrorhynchus* on *Acer pseudoplatanus*; B – *Aceria stenaspis* on *Fagus sylvatica*; C – *Eriophyes macrotrichus* on *Carpinus betulus*

For example, *Phytoptus padi* causing galls on *Prunus padus* and *P. spinosa*, was the most abundant eriophyid species in the past. It has been cited in 45 contributions of Bayer, Baudyš and Černík. At present it belongs to rare species and it was found only at four localities. *Artacris macrorhynchus* inducing galls on *Acer pseudoplatanus* and *A. campestre* has at present the same population density as in the past and may be considered to one of the most abundant species in the Czech Republic. Similarly *Phytoptus tiliae* causing galls on *Tilia platyphyllos* and *T. cordata* seems to have the same population density at present as in the past. *Epitrimerus trilobus* changing into galls the leaflets of *Sambucus nigra* is at present more abundant than it was in the past.

At present the most abundant eriophyid mite species is *Artacris macrorhynchus* causing galls on *Acer pseudoplatanus*. Its galls were found at 34 localities. It is possible to find its galls practically on each maple tree. Other species, *Aceria stenaspis* producing galls on *Fagus sylvatica*, occurs in higher altitudinal zones and may be assigned to be a mountain species. *Eriophyes macrotrichus* causing leaf furrowing on *Carpinus betulus* which occurs mainly in warmer parts of the Czech Republic may be considered to be a thermophilous species (Fig. 2).

Several eriophyid species which occurred abundantly in the past, occur scarcely at present or seems to be entirely disappeared from the territory of the Czech Republic.

The following species belong to disappearing or quite disappeared eriophyid mite species (the stage in 1986):

Eriophyes platanoideus on *Acer pseudoplatanus*

Vasates hippocastani on *Aesculus hippocastani*

Eriophyes convolvens on *Euonymus europaeus*

Cecidophyopsis ribis on *Ribes grossularia*

Phytoptus loewi on *Syringa vulgaris*

Colomerus vitis; this species causing galls on the leaves of *Vitis vinifera* has not been recorded since 1950 and it seems to be a disappeared species. This fact may be in connection with long-termed, intensive and repeated chemical control which is used since that time in vineyards.

Populations of eriophyid mites probably similarly to the populations of other animals are influenced by many ecological factors and their density may change in the course of several years.

Occurrence in 1978–1986

Galls of eriophyid mites occur scattered over the whole territory of the Czech Republic, from lowlands up to mountains. Galls occur usually in small number and low local quantity (density), as a single gall or several galls on solitary leaves of one tree or shrub. On the other hand, it is possible to find out trees and shrubs the leaves of which are fully covered with eriophyid galls. In such cases the surface of attacked leaves is restricted and, therefore, the assimilation processes are reduced which may influence the health stage of such trees and shrubs and their predisposition to diseases.

Taking it all in all, 50 eriophyid mite species were ascertained at 75 localities of the Czech Republic during investigations in the period 1978–1986 (see Table 2). Examined localities were situated in various altitudes from 173 m a. s. l. at Lednice in southern Moravia up to 1202 m a. s. l. at Špičák in the Šumava Mts. in south-western Bohemia.

Eriophyid mite species found in the territory of the Czech Republic may be divided at least into three frequency groups based on their occurrence at localities in the explored area, viz. species occurring scarcely, species of middle abundance and species occurring abundantly (commonly).

Tab 5 A systematic review of eriophyid mite species including their host plant species and distribution

Eriophyid mite species	Host plant species	Distribution (number of contributions)
<i>Acalitus breviaratus</i> (Focke, 1890)	<i>Alnus glutinosa</i> , <i>A. incana</i>	31
– <i>phloeoptes</i> (Nalepa, 1890)	<i>Prunus spinosa</i> , <i>P. domestica</i> , <i>Cotoneaster</i>	10
– <i>rudis</i> (Canestrini, 1890)	<i>Betula pubescens</i> , other sp.	13
<i>Acaphylla salicobius</i> (Nalepa, 1889)	<i>Salix alba</i>	1
– <i>irritus</i> (Nalepa, 1892)	<i>Alnus glutinosa</i> , <i>A. incana</i>	4
<i>Aceria annulata</i> (Nalepa, 1899)	<i>Rhamnus cathartica</i>	3
– <i>blastophthira</i> (Nalepa, 1919)	<i>Fagus sylvatica</i>	1
– <i>crassipunctata</i> (Nalepa, 1911)	<i>Acer campestre</i> , <i>A. pseudoplatanus</i>	1
– <i>exilis</i> (Nalepa, 1891)	<i>Tilia platyphyllos</i> , <i>T. cordata</i>	22
– <i>gemmarum</i> (Nalepa, 1892)	<i>Salix caprea</i>	5
– <i>phicans</i> (Nalepa, 1919)	<i>Fagus sylvatica</i>	2
– <i>salicina</i> (Nalepa, 1889)	<i>Salix caprea</i> and other species	7
– <i>scaber</i> (Nalepa, 1895)	<i>Ribes alpinum</i> , <i>R. nigrum</i> , <i>R. rubrum</i>	1
– <i>stenaspis</i> (Nalepa, 1891)	<i>Fagus sylvatica</i>	11
– <i>varia</i> (Nalepa, 1892)	<i>Populus tremula</i>	12
<i>Aculops aceris</i> (Nalepa, 1894)	<i>Acer campestre</i>	6
– <i>tetanothrix</i> (Nalepa, 1889)	<i>Salix fragilis</i> and other sp.	31
<i>Aculus brevipunctatus</i> (Nalepa, 1889)	<i>Ulmus</i> , various sp.	15
– <i>dispar</i> (Nalepa, 1891)	<i>Populus tremula</i> , <i>P. alba</i>	12
– <i>epiphyllus</i> (Nalepa, 1894)	<i>Fraxinus excelsior</i> , <i>F. ornus</i>	4
– <i>truncatus</i> (Nalepa, 1925)	<i>Salix purpurea</i>	12
– <i>ulmicola</i> (Nalepa, 1909)	<i>Ulmus campestris</i>	6
<i>Artacris macrorhynchus</i> (Nalepa, 1889)	<i>Acer pseudoplatanus</i> , <i>A. campestre</i> and other sp.	37
<i>Cecidophyes betulae</i> (Nalepa, 1891)	<i>Betula pubescens</i>	3
– <i>psilonotus</i> (Nalepa, 1899)	<i>Euonymus europaeus</i>	1
<i>Cecidophyopsis psilaspis</i> (Nalepa, 1895)	<i>Taxus baccata</i>	1
– <i>ribis</i> (Westwood, 1869)	<i>Ribes alpinum</i> , <i>R. nigrum</i>	12
– <i>vermiformis</i> (Nalepa, 1889)	<i>Corylus avellana</i>	3
<i>Colomerus vius</i> (Pagenstecher, 1858)	<i>Vitis vinifera</i>	10
<i>Coptophylla gymnaspsis</i> (Nalepa, 1894)	<i>Acer pseudoplatanus</i> , <i>A. campestre</i> , <i>A. platanoides</i>	5
<i>Eptimerus pyri</i> (Nalepa, 1892)	<i>Pyrus communis</i>	13
– <i>trilobus</i> (Nalepa, 1890)	<i>Sambucus nigra</i> and other sp.	24
<i>Eriophyes acericola</i> Garman, 1883	<i>Acer saccharinum</i>	1
– <i>calycobius</i> (Nalepa, 1891)	<i>Crataegus oxyacantha</i>	1
– <i>calycopthirus</i> (Nalepa, 1891)	<i>Betula verrucosa</i>	10
– <i>convolvens</i> (Nalepa, 1892)	<i>Euonymus europaeus</i>	11
– <i>crataegi</i> (Canestrini, 1890)	<i>Crataegus oxyacantha</i>	2
– <i>crataegumplicans</i> Cotte, 1910	<i>Crataegus oxyacantha</i>	1
– <i>diversipunctatus</i> (Nalepa, 1890)	<i>Populus tremula</i>	17
– <i>erineus</i> (Nalepa, 1891)	<i>Juglans regia</i>	15
– <i>erobius</i> Nalepa, 1922	<i>Acer pseudoplatanus</i>	8
– <i>filiformis</i> (Nalepa, 1891)	<i>Ulmus campestris</i>	9
– <i>fraxinicola</i> (Nalepa, 1890)	<i>Fraxinus excelsior</i>	4
– <i>fraxinivorus</i> Nalepa, 1909	<i>Fraxinus excelsior</i> and other species	14
– <i>heteronyx</i> (Nalepa, 1891)	<i>Acer campestre</i> , <i>A. platanoides</i>	2
– <i>inangulis</i> (Nalepa, 1919)	<i>Alnus glutinosa</i>	16
– <i>liosoma</i> (Nalepa, 1892)	<i>Tilia platyphyllos</i> , <i>T. cordata</i>	22
– <i>longirostris</i> Nalepa, 1919	<i>Alnus glutinosa</i> , <i>A. incana</i>	1
– <i>longisetosus</i> (Nalepa, 1892)	<i>Betula pubescens</i> , <i>B. verrucosa</i>	7
– <i>macrochelus</i> (Nalepa, 1891)	<i>Acer campestre</i> , <i>A. pseudoplatanus</i>	16
– <i>macrotrichus</i> (Nalepa, 1919)	<i>Carpinus betulus</i>	16
	* <i>Ostrya carpinifolia</i>	1
– <i>nervisequus</i> (Canestrini, 1892)	<i>Fagus sylvatica</i>	15

Tab. 5 (continued)

Eriophyid mite species	Host plant species	Distribution (number of contributions)
– <i>paderineus</i> Nalepa, 1909	<i>Prunus padus</i>	9
– <i>platanoides</i> (Nalepa, 1922)	<i>Acer platanoides</i> , <i>A. saccharinum</i>	8
– <i>populi</i> (Nalepa, 1890)	<i>Populus tremula</i> , <i>P. nigra</i>	15
– <i>pseudoplatani</i> Corti, 1904	<i>Acer pseudoplatanus</i> , <i>A. saccharinum</i>	19
– <i>quercinus</i> (Canestrini, 1891)	<i>Quercus pubescens</i>	3
– <i>rubicolens</i> (Canestrini, 1892)	<i>Rubus fruticosus</i>	2
– <i>sorbeus</i> (Nalepa, 1926)	<i>Sorbus aucuparia</i>	5
– <i>tenellus</i> (Nalepa, 1919)	<i>Carpinus betulus</i>	8
– <i>tristriatus</i> (Nalepa, 1890)	<i>Juglans regia</i>	10
– <i>vermicularis</i> Nalepa, 1922	<i>Acer obtusatum</i>	1
– <i>viburni</i> (Nalepa, 1889)	<i>Viburnum lantana</i>	5
<i>Phyllocoptes fraxini</i> Nalepa, 1894	<i>Fraxinus excelsior</i>	1
– <i>gibbosus</i> (Nalepa, 1895)	<i>Rubus caesius</i> and o.	17
– <i>goniothorax</i> (Nalepa, 1889)	<i>Crataegus oxyacantha</i> , <i>Malus sylvestris</i>	25
– <i>gracilis</i> (Nalepa, 1891)	<i>Rubus caesius</i> and other species	7
– <i>lionotus</i> (Nalepa, 1891)	<i>Betula pubescens</i> and other species	11
– <i>magnirostris</i> Nalepa, 1895	<i>Salix alba</i> and other species	10
– <i>phytoptoides</i> Nalepa, 1890	<i>Salix babylonica</i>	6
– <i>populi</i> (Nalepa, 1892)	<i>Populus tremula</i> , <i>P. nigra</i>	19
– <i>xylostei</i> (Canestrini, 1892)	<i>Lonicera xylosteum</i>	6
<i>Phytocoptella avellanae</i> (Nalepa, 1889)	<i>Corylus avellana</i>	17
– <i>tetratrichus</i> Nalepa, 1891	<i>Tilia cordata</i> , <i>T. platyphyllos</i>	20
<i>Phytoptus laevis</i> Nalepa, 1889	<i>Alnus glutinosa</i> , <i>A. incana</i>	26
– <i>loewi</i> (Nalepa, 1890)	<i>Syringa vulgaris</i>	14
– <i>marginemtorquens</i> (Nalepa, 1926)	<i>Pyrus communis</i>	12
– <i>padi</i> Nalepa, 1890	<i>Prunus padus</i> , <i>P. spinosa</i> , <i>P. domestica</i>	45
– <i>pyri</i> (Pagenstecher, 1859)	<i>Pyrus communis</i> , other species and genera	
	<i>Pyrus</i>	15
	<i>Cotoneaster</i>	2
– <i>similis</i> Nalepa, 1889	<i>Prunus domestica</i> , <i>P. spinosa</i>	31
– <i>sorbi</i> Canestrini, 1892	<i>Sorbus aucuparia</i> and other species	17
– <i>tiliae</i> (Pagenstecher, 1857)	<i>Tilia platyphyllos</i> , <i>T. cordata</i> and other species	33
<i>Stenacis triradiatus</i> (Nalepa, 1892)	<i>Salix alba</i> and other species	20
<i>Trisetacus floricolus</i> Trotter, 1902	<i>Abies alba</i>	1
– <i>juniperinus</i> (Nalepa, 1910)	<i>Juniperus communis</i>	1
– <i>pini</i> (Nalepa, 1887)	<i>Pinus sylvestris</i> , <i>Pinus mugo</i> , <i>Larix decidua</i>	11
<i>Vasates hippocastani</i> (Focke, 1890)	<i>Aesculus hippocastanum</i>	12
– <i>phyllocoptoides</i> (Nalepa, 1891)	<i>Salix purpurea</i>	1
– <i>robiniae</i> (Nalepa, 1894)	<i>Robinia pseudoacacia</i>	4

The first frequency group includes eriophyid mite species occurring scarcely and found from one up to five localities. 28 eriophyid mite species belong in this group, that is more than 50% of all eriophyid species found in the Czech Republic. Galls of such eriophyid mites occur in a low local quantity and their occurrence is influenced mainly by the species composition of trees and shrubs at the examined locality.

The second frequency group includes eriophyid mite species of the middle occurrence and found from six up to fourteen localities. 19 eriophyid mite species (36%) may be involved in it. These eriophyid mites cause galls mainly on trees and shrubs which occur abundantly in all explored localities of the Czech Republic from lowlands up to mountains.

The third frequency group includes eriophyid mite species occurring abundantly and found from fifteen up to thirty localities. The following six eriophyid mite species (10%) belong in this group:

- *Eriophyes pseudoplatani* causing galls on the leaves of *Acer pseudoplatanus* found at 15 localities;
- *Eriophyes liosoma* producing galls on the leaves of *Tilia cordata* found at 16 localities;
- *Phyllocoptes populi* causing galls on the leaves of *Populus tremula* found at 18 localities;
- *Phytoptus tiliae* inducing galls on the leaves of *Tilia platyphyllos* and *T. cordata* found at 18 localities;
- *Phytoptus laevis* causing galls on the leaves of *Alnus glutinosa* found at 19 localities;
- *Artacris macrorhynchus* causing galls on the leaves of *Acer pseudoplatanus* belongs to the most abundant species being found at 34 localities from lowland up to mountain.

Host plant and animal relations

Some plant genera and species provide better conditions for development of eriophyid mites and usually also for other gall-making animals than other plant genera and species which is connected probably with chemical processes and with chemical composition of plant tissues of such plant species and genera. For example, in the Czech Republic eleven eriophyid mite species are bound by their development to the genus *Acer*, five to the genera *Alnus* and *Betula* and four to the genus *Fagus*.

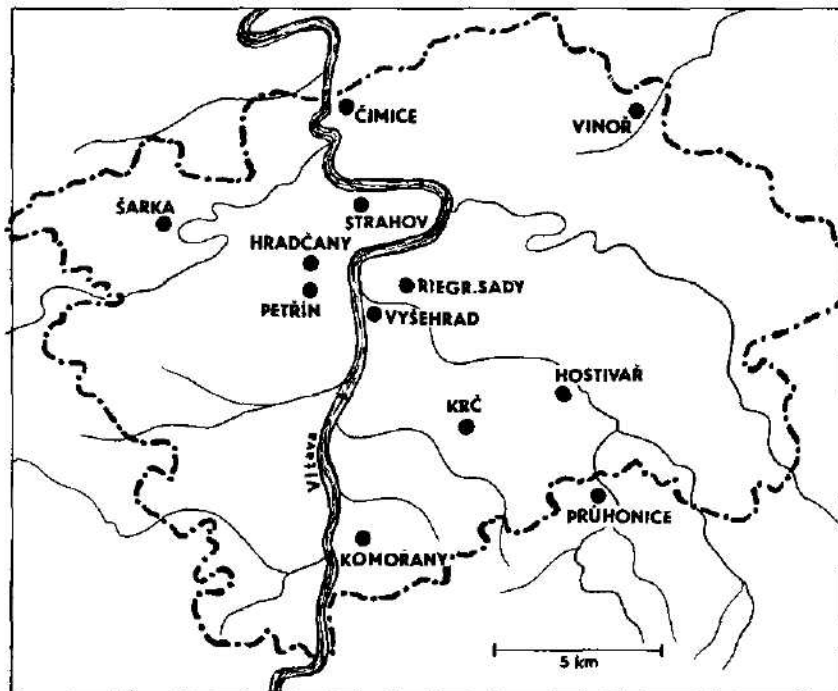


Fig. 3. The territory of the city Praha with localities (black circles) where the investigations of eriophyid mite fauna were done.

Concerning the plant-animal relations on the specific level, four eriophyid mite species are bound to *Acer campestre*, other four eriophyid species to *Alnus glutinosa* and other four species to *Tilia platyphyllos*. Three eriophyid species develop on *Betula pubescens*, *Fagus sylvatica*, *Populus tremula* and *Salix caprea*; two eriophyid species on *Acer pseudoplatanus*, *Carpinus betulus*, *Juglans regia*, *Prunus domestica*, *Sorbus aucuparia* and *Ulmus*. Only one eriophyid mite species to develop on one host plant species as, for example, *Vasates hippocastani* on *Aesculus hippocastani*.

Number of eriophyid species and genera

A systematic review of 90 eriophyid mite species recorded on trees and shrubs in the Czech Republic during investigations conducted in the 20th century, according to the taxonomical and nomenclatorial interpretation in Davis et al. (1982), is given in the Table 5. The eriophyid mite species belong to 18 genera from which the most abundant genus is *Eriophyes* von Siebold, 1850, including 31 species, forming galls on various trees and shrubs in the Czech Republic. In the last column there is given the frequency of such eriophyid mite species in the number of contributions (or citations) of researchers, viz. Bayer, Baudyš and Černík. We suppose that particular eriophyid mite species is present in a definitive area when it had been found and such finding had been recorded in a contribution of a researcher who investigated that area.

Occurrence of eriophyid mite species on trees and shrubs in the territory of the city Praha

Thirty seven eriophyid mite species causing galls on trees and shrubs of 23 host plant species were found at twelve localities lying at the territory of the city Praha and its adjacent areas (Fig. 3 and Table 6). The following three eriophyid mite species may be ranged in the group of the most abundant species in this area:

- *Eriophyes liosoma* causing galls on the leaves of *Tilia cordata* which have been found at 10 localities;
- *Epitrimerus trilobus* developing in galls on the leaves of *Sambucus nigra* found at 9 localities;
- *Artacris macrorhynchus* inducing galls on the leaves of *Acer pseudoplatanus* found at 7 localities.

The comparison of the occurrence of eriophyid mite species in the territory of the whole Czech Republic with their occurrence at the area of the city Praha shows that the degree of the injury caused by eriophyid mites to shrubs and trees is not identical in both areas. Conspicuous differences have been found in local abundance and in the frequency of galls of several eriophyid mite species.

Artacris macrorhynchus, the most abundant species in the territory of the Czech Republic, is not so abundant in the area of the city Praha. On the contrary, *Eriophyes liosoma*, which occurs not so frequently in the territory of the Czech Republic, belongs at present (1986) to the very abundant eriophyid mite species in the area of the city Praha. *Epitrimerus trilobus*, the middle abundantly occurring species in the territory of the Czech Republic, belongs into the group of the most abundant species in the territory of Praha. Galls of *Eriophyes liosoma* and *Epitrimerus trilobus* may be found nearly at each examined locality in the area of the city Praha.

It seems that these two eriophyid mite species are well adapted for survival in the unfavourable and life deteriorating conditions in the city agglomeration of Praha. The rising occurrence of galls of *Epitrimerus trilobus* which was observed in last years is probably connected with the increasing occurrence of its host plant species, *Sambucus nigra*, which as a member of the

Tab 6 Occurrence of eriophyid mite species at localities in the area of the city Praha during 1978–1986. Names of localities 1 Vyšehrad; 2 Čimický háj; 3 Stromovka; 4 Vinohř; 5 Šárka; 6 Komořany; 7 Průhonice; 8 Krčský les; 9 Riegrovy sady; 10 Hradčany; 11 Hostivař; 12 Petřínské sady

Host plantspecies	Eriophyid mite species	Localities											
		1	2	3	4	5	6	7	8	9	10	11	12
<i>Acer campestre</i>	<i>Eriophyes macrochelus</i>					+	+	+	+				
	<i>Aceria crassipunctata</i>					+							
	<i>Artacris macrorhynchus</i>			+			+	+					
<i>A pseudoplatanus</i>	<i>Artacris macrorhynchus</i>	+	+	+		+		+	+	+			
	<i>Eriophyes eriobia</i>					+							
<i>A saccharinum</i>	<i>Eriophyes vermicularis</i>							+					
	<i>Eriophyes acericola</i>							+					
<i>Aesculus hippocastanum</i>	<i>Vasates hippocastani</i>			+									
<i>Alnus glutinosa</i>	<i>Phytoptus laevis</i>				+	+		+					
	<i>Eriophyes inangulis</i>				+	+		+	+			+	
	<i>Acalitus brevitarsus</i>				+	+		+	+			+	
<i>Carpinus betulus</i>	<i>Eriophyes macrotrichus</i>							+					
<i>Corylus avellana</i>	<i>Phytocoptella avellanae</i>					+							
<i>Crataegus oxyac.</i>	<i>Phyllocoptes goniothorax</i>							+					
	<i>Eriophyes calycobius</i>						+						
<i>Euonymus europaeus</i>	<i>Eriophyes convolvens</i>							+					
	<i>Cecidophyes psilonotus</i>							+					
	<i>Aceria stenaspis</i>							+					
<i>Fagus sylvatica</i>	<i>Aceria plicans</i>								+				
	<i>Eriophyes nervisequus</i>							+					
	<i>Phyllocoptes fraxini</i>							+					
<i>Fraxinus excelsior</i>	<i>Eriophyes fraxinivorus</i>						+						
	<i>Eriophyes erineus</i>						+						
<i>Juglans regia</i>	<i>Aceria varia</i>				+		+						
<i>Populus tremula</i>	<i>Phytoptus padi</i>			+				+					
<i>Prunus padus</i>	<i>Eriophyes paderneus</i>							+					
	<i>Phytoptus similis</i>							+					
<i>Prunus spinosa</i>	<i>Aculops tetanothrix</i>							+					
	<i>Stenacis triradiatus</i>	+											
<i>Salix caprea</i>	<i>Eptimerus trilobus</i>	+	+	+	+	+	+		+			+	+
<i>Sambucus nigra</i>	<i>Eriophyes sorbeus</i>	+											
<i>Sorbus aucuparia</i>	<i>Cecidophyop psilaspis</i>	+											
<i>Taxus baccata</i>	<i>Phytoptus uliae</i>	+		+				+	+			+	
<i>Tilia cordata</i>	<i>Aceria exilis</i>			+		+		+	+			+	
<i>T. platyphyllos</i>	<i>Phytocoptella tetratrichus</i>	+				+		+	+			+	+
<i>Ulmus laevis</i>	<i>Eriophyes hosoma</i>	+	+	+		+		+	+	+	+	+	+
	<i>Aculus ulmicola</i>							+	+				

ruderal plant association is expanded considerable in the surroundings of the city Praha. Almost each specimen of this shrub growing at the area of Praha is injured by galls of *Eptimerus trilobus*.

Twenty three eriophyid mites species were found only once and in a very low local density. The occurrence of such eriophyid species is not important.

Very rich composition of the eriophyid fauna – together 22 eriophyid mite species – was found on trees and shrubs in the Park and Botanical Garden at Průhonice, about 10 km southern from

Praha. Relatively rich was eriophyid composition (13 species) in the Šárcecké údolí Valley, eleven species were found in the Krčský les Forest, eight species at Stromovka and at Vyšehrad, seven species at the localities Komořany and Hostivař, five species at Vinoř, three species at localities Čimický háj and Petřínské sady, two species at Riegrovy sady and one species in the park near Hradčany Castle.

The species composition of eriophyid mites at localities in the central part of the city Praha with deteriorated environment (Riegrovy sady, Hradčany, Petřín) is more poor than the eriophyid composition at localities in the border part of Praha (Průhonice, Šárka, Krčský les) where the environment is more better and the species composition of host plant including trees and shrubs is more richer.

The relatively low number of eriophyid mite species at localities Vinoř, Komořany and Čimický háj is probably caused by the relatively poor species diversity of trees and shrubs. Mainly oaks grow at Komořany and in the Čimický háj whereas alder trees grow in the Vinoř-forest.

DISCUSSION

Data about occurrence of eriophyid mites in various countries of Europe and also in the territory of the Czech Republic are scattered in many contributions of various researchers. Present paper is the first summarization of such data. It brings a review of eriophyid mites which develop on trees and shrubs in our country.

During about sixty years, 1910–1969, the earlier Czech researchers, viz. Bayer, Baudyš and Černík, found 90 eriophyid mite species causing galls on trees and shrubs in various parts of the Czech Republic and reported about their occurrence in 62 contributions. During nine years, 1978–1986, 50 eriophyid mite species were ascertained in the territory of the Czech Republic and 37 species in the territory of the city Praha. A comparison of gathered data makes it possible not only to evaluate the present stage of eriophyid mite fauna but also to outline long-term changes in population dynamics of eriophyid mites.

It would be very interesting to compare data about occurrence of eriophyid mites in the Czech Republic with such data gathered in other European countries. Unfortunately till present such studies have not been done. Summarizations and comparisons are very useful and are necessary presuppositions for subsequent zoogeographical studies.

Only Buhr (1964–1965) in his fundamental two-volumes book about galls mentioned that about 350 eriophyid mite species causing galls occur in the territory of central and northern Europe.

At present there are at disposal for such considerations only data gathered in the area of applied entomology and acarology. For example, Boczek (1970) mentioned six eriophyid mite species developing on trees and shrubs in orchards and Boczek & Chyczewski (1970) twelve eriophyid mite species on coniferous trees in Poland.

Hrubík (1988) in the frame-work of his systematic research of the pests developing on trees and shrubs of urban greenery in Slovakia, carried out in three towns, viz. in Bratislava, Nitra and Žilina, found galls of 25 eriophyid mite species. His results are in accordance with our findings of 37 eriophyid species found in the territory of the city Praha.

SUMMARY

1. In the 20th century 90 eriophyid mite species belonging to the superfamily Eriophyoidea which induce galls on trees and shrubs occurred in the territory of the Czech Republic.
2. The population density of eriophyid mites change in long-term intervals; some eriophyid species which were abundant in the past belong to disappearing species at present and several eriophyid species which were rare in the past are abundant at present.
3. 50 eriophyid mite species causing galls on 26 host plant species were recorded at 75 localities in the territory of the Czech Republic during period 1978–1986.
4. All eriophyid mites are divided, based on their occurrence in localities of the Czech Republic, into three frequency groups, viz. species occurring scarcely (28 species, 50%), species of middle occurrence (19 species, 36%) and species occurring abundantly (5 species, 10%). *Eriophyes pseudoplatani*, *Eriophyes lisoma*, *Phyllocoptes populi*, *Phytoptus laevis* and *Artacris macrorhynchus* belong to the most abundant eriophyid mite species in the Czech Republic.
5. 37 eriophyid mite species causing galls on 23 host plant species were recorded at twelve localities lying in the territory of the city Praha. *Eriosoma lisoma*, *Epirimerus trilobus* and *Artacris macrorhynchus* belong to the most abundant species there.
6. Eriophyid mite species occur at localities in the Czech Republic and also at localities in the territory of the city Praha usually scattered, in relatively low local quantity and do not cause conspicuous injury to their host plants.
7. In the 20th century the following eriophyid species occurred as pests in the Czech Republic: *Eriophyes fraxinivorus* changing into galls the inflorescences of *Fraxinus excelsior*; *Eriophyes platanoides* galling young leaves of *Acer platanoides*; *Phytoptus pyri* causing galls on the leaves of *Pyrus communis*; *Stenacis triradiatus* producing large bud deformations, so called witches-broom, on various species of *Salix*.

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Distributional patterns of bats (Mammalia: Chiroptera) in Slovakia. Part 1, Horseshoe bats (Rhinolophidae)

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Abstract All available distributional data of three horseshoe bats species *Rhinolophus ferrumequinum* (Schreber, 1774), *Rhinolophus hipposideros* (Bechstein, 1800), and *Rhinolophus euryale* Blasius, 1853, in Slovakia are presented. Altitudinal range and changes in numbers were also analysed. *R. ferrumequinum* was recorded in 109 localities (altitudinal range 200–500 m a. s. l.), *R. hipposideros* in 344 localities (100–1488 m a. s. l.) and *R. euryale* in 30 localities (220–943 m a. s. l.). Two horseshoe bat species, *R. ferrumequinum* and *R. euryale*, reach in Slovakia northern margins of their distributional ranges. The population of *R. euryale* is an unique example of an isolated subpopulation situated far distant from the other range of the species. Abundance in all three species seems to be stable and at least in recent period population of *R. hipposideros* is characterized with a slight increase.

Rhinolophidae, distribution, changes in numbers, Slovakia

INTRODUCTION

The first comprehensive book on mammals in Slovakia was published in 1965 (Feriancová-Masárová & Hanák 1965). It contains basic distributional and biological characteristics of bats in Slovakia. It was written on the basis of older literature about bats in Slovakia (e. g. Mošanský 1957, Gaisler 1956, Vachold 1955a, b, 1956, 1961). Since that time amount of data has considerably increased and several reviews have appeared (e. g. Gaisler & Hanák 1972, Horáček et al. 1979, Mošanský 1980, Danko & Mihók 1989, etc.) in addition to a number of regional faunal papers (e. g. Anděra et al. 1982, Bárta 1976, 1978, Danko & Beneš 1976, Grimmberger 1983, Kaňuch & Takáč 1988, Ligač 1986, Obuch 1983, Uhrin 1993a, 1994, etc.).

The major aim of this paper is to summarize and evaluate the data about the distribution of bats in Slovakia. This part focuses to the knowledge about three species of horseshoe bats, *Rhinolophus ferrumequinum*, *R. hipposideros* and *R. euryale*. A part concerning on *Myotis daubentonii* and *M. dasycneme* has already been published (Uhrin et al. 1995a).

There are few papers published about rhinolophid species in Slovakia. Records of *R. ferrumequinum* till 1956 were compiled by Šebek (1956). Horáček & Červený (1984) and Horáček & Zima (1979) published faunal analysis emphasizing the cases of synanthropy in *R. ferrumequinum* and *R. euryale*. Data coming from Slovakia were used in papers on ecology of lesser horseshoe bat, *R. hipposideros* (e. g. Gaisler 1963). Information on the abundance of the hibernating population of *R. euryale* in Domica cave (Uhrin 1992) and also a short faunistic report on the

new winter locality of the same species outside the known distribution area were published by Uhrin (1993a). Besides these papers there are two contributions about the findings of unusually coloured individuals of *R. hipposideros* (Danko 1995, Horáček 1995). Kryštufek (1993) used material also from localities in Slovakia for analyses of geographical variability in *R. ferrumequinum* and Zima (1982) presented karyotypes of all three species. Helminthofauna of the family Rhinolophidae in Slovakia was surveyed by Mituch (1964). Results of bat banding, including data from horseshoe bats were presented in several papers (Gaisler & Hanák 1969a, b, Hanák et al. 1962, Palášthy 1987). The preliminary version of our study was presented by Uhrin (1995a).

MATERIAL AND METHODS

The paper is based on all available records from Slovakia, both published and unpublished. Data were collected using checks of underground spaces of different types, checks in lofts, netting, and analyses of bone remains in owl pellets and in fissure and cave thanatocenoses. Data from some papers, which do not inform about the number of bats found (e.g. Grulich & Povolný 1955, 1956, Mošanský 1980, Krištofik 1982, Dudich & Matoušek 1985, etc.), were included in the surveys of the records only when they represent a sole report on the locality and/or a year period different than other data. Material is evaluated till the end of 1995.

For each species, concrete findings and observations are given. Data are prepared using the mapping grid of Slovakian Fauna Databank 12 0×11.2 km), names and numbers of the geomorphological units are used after Kroupová (1980). Reviews of the localities and findings are arranged after geomorphological units of Slovakia and there we give the number of the square of the mapping grid, altitude and reference or abbreviation of the author (Be – Benda, Da – Danko, Fu – Fulín, Ha – Hanák, Ho – Horáček, Hri – Hrivnák, Ka – Kaňuch, Ko – Kotlarčík, Le – B. and R. Lehotski, Ma – Matis, Na – Nadzamová, Pa – Pačénovský, Pj – Pjenčák, Rci – Reiter, Sý – Sýkora, Ta – Takáč, Te – Tencec, Th – Thomka, Uh – Uhrin, Zu – Zukal). We use following abbreviations: m – male, f – female, a – adult, s – subadult, j – juvenile, si – sex undetermined, net. – netted, capt – captured, obs. – observed, det. – detected, ind – individual, c – cave, thanat. – thanatocenose.

RESULTS AND DISCUSSION

Rhinolophus ferrumequinum (Schreber, 1774)

Survey of the records

Muránska planina Mts. (021)

1. Bobačka c. (7286), 770 m: 7.3.1993: 5si (Uh), upper part. 7.1.1982: 1si (Ho), 6.2.1994: 2si, 27.11.1994: 4si, 15.2.1995: 5si, lower part. 27.11.1994: 1si, 14.2.1995: 1si (Uh). **2. Brestová c.** (7286), 550 m: 17.7.1978: 1ma, 2ms net. (Horáček et al. 1979, 1995), 2.5.1993: 1 torpid, 1ma net., 1.9.1994: 1ma net., 8.12.1994: 1si, 25.7.1995: 1ma net., **3. Dielík-Tunel** (7285), 500 m: 17.2.1994: 1si, 8.2.1995: 2si (Uh). **4. Hradová c.** (7385), 700–800 m: 22.9.1980: 1si (Darola et al. 1985), **5. Husleho c.** (7285), 520 m: 20.2.1993: 1si (Uh). **6. Javorníková valley c.** (7286), ca 700 m: 6.4.1979: 1si (Darola et al. 1985), **7. Kostolík c.** (7385), 479 m: 15.2.1961: 3 ind (Gaisler & Hanák 1972), 6.11.1993: 1si, 29.1.1995: 1si (Uh), **8. Michňová c.** (7385), 600 m: 5.2.1988: 1si (Horáček et al.), 19.1.1993: 1si, 19.2.1993: 1si, 6.11.1993: 1si (Uh et al.), **9. Muráň**, loft of house (7286), 394 m: 11.6.1975, 12.6.1975: 1ma (Hanák & Anděra 1980, Horáček et al. 1979), **10. Na Osiskách c.** (7286), 530 m: 14.2.1975: 5si (Hanák & Anděra 1980), 19.2.1993: 1si, 17.11.1993: 1si, 1.2.1995: 2si (Uh), **11. Šarkanica c.** (7285), 800 m: 17.2.1994: 1si (Uh, Ob), **12. Tisovec** (7385), 411 m: 16.2.1961 (Štollmann 1968a), loft of cath. church. 14.7.1993: 1si, loft of evang. church: 10.8.1994: 1si (Uh).

Slovenský raj Mts. (022)

13. Čertova diera c. (7088), 700–800 m: 31.10.1994: 1si (Da), **14. Medvedia c.** (7088), 914 m: 7.4.1972: 1 obs. (Košč 1976).

Revúcka vrchovina Mts. (040)

15. Drienčany, stream (7586), 243 m: 7.7.1981: 2 obs. (Horáček et al. 1995), **16. Gemerská Poloma**, loft of church (7288), 334 m: 1.8.1994: 1 obs., **17. Gočovo**, loft of church (7288), 380 m: 1.8.1994: 1 obs., **18. Henckovce** (7288), 360 m: loft of church: 1.8.1994: 1 obs., loft of another church: 1.8.1994: 2 obs., **19. Kobeliarovo**, loft of church (7288), 481 m: 1.8.1994: 1 obs., **20. Lipovec**, loft of evang. church (7486), 528 m: 5.6.1995: 50 obs., food of *T. alba*: 1 ind., **21. Muránska Dlhá Lúka**, (7286), 345 m: loft of evang. church: 3.6.1993: 1si, loft of cath. church: 21.7.1992: 1si (Uhrin & Benda 1995, Uhrin et al. 1996), **22. Nandraž**, loft of church tower (7387), 280 m: 12.6.1975: 1 obs. (Horáček et al. 1979), **23. Nižný Skalník**, loft of church (7585), 234 m: 26.6.1982: 2 si. (Horáček & Červený 1984, Horáček et al. 1995), **24. Nováčany**,

loft of church (7487), 280 m: 22.7.1995: 1 obs., **25. Prihradzaný**, loft of church (7487), 280 m: 30.8.1992: 1s1, **26. Španie Pole**, loft of church tower (7486), 370 m: 5.6.1995: 2 obs., **27. Špaňopolská c.** (7486), 301 m: 9.7.1981: 1s1 obs. (Horáček et al. 1995), 30.11.1994: 1s1 (Uhrin & Benda 1995, Uhrin et al. 1996), **28. Veľká Drienčanská c.** (7586), 280 m: 17.9.1954: 1m capt. (Vachold 1960, Šebek 1956), 16.10.1954: ?m capt. (Vachold 1955), 7.8.1980: 1ms net., 8.8.1980: 1ma net. (Horáček & Červený 1984), 14.5.1983: 1ma net. (Horáček et al. 1995), 11.9.1995: 1fa, 1mj net. (Uhrin & Benda 1995, Uhrin et al. 1996), **29. Veľký Blh** (7586), 216 m: loft of church: 8.8.1980: 3s1 obs. (Horáček et al. 1979, 1995), loft of castle: 28.6.1982: 1s1 obs. (Horáček & Červený 1984, Horáček et al. 1995), **30. V Maruškinom jarku c.** (7486), 260 m: 12.9.1995: 1 activ obs. (Uhrin & Benda 1995, Uhrin et al. 1996), **31. Vyšné Valice**, loft of church (7587), 240 m: 28.6.1982: 1s1 obs. (Horáček & Červený 1984, Horáček et al. 1995), **32. Zráz**, gallery (7386), 460 m: 13.12.1992: 1s1 (Uhrin & Benda 1995, Uhrin et al. 1996).

Rožňavská kotlina basin (050)

33. Rožňava (7389), 318 m: 1.3.1961: 1ma capt. (Štollmann 1968a).

Slovenský kras Mts (060)

34. Arčovská c. (7488), 314 m: 15.9.1949: 1m capt., 14.10.1954: 2m capt. (Vachold 1955, Šebek 1956), 14.11.1955: 9m, 5fcapt., 18.3.1956: 1m capt., 28.6.1956: 3m, 1fcapt., 8.2.1957: 2m capt., 16.2.1958: 3m, 1fcapt. (Vachold 1960), 9.12.1956: 10 ind., 5.2.1958: 1 ind., 4.3.1963: 1 ind., 13.2.1969: 2 ind., 3.2.1970: 1 ind. (Gaisler & Hanák 1972), 15.8.1970: 1ma net. (Horáček et al. 1979), 22.2.1979: 4s1, 20.2.1980 (Ho), 14.11.1991: 5s1, 20.1.1993: 3s1, 15.2.1994: 2s1, 16.2.1995: 2s1 (Uh et al.), **35. Brzotín**, road to Slavec (7388), 200–300 m: 30.8.1982: 1 ind. dead, tower of evang. church: 24.4.1989: 2s1 (Horáček et al. 1995), **36. Brzotínska c.** (7388), 270 m: 11.8.1974: 2ms net. (Horáček et al. 1979), 13.2.1993: 7s1, 16.2.1994: 6s1 (Uh et al.), **37. Červený Kameň c.** (7489), ca 500 m: 21.7.1978: 1 net. (Horáček et al. 1979, 1995), **38. Čertova diera c.** (7588), 370 m: 12.8.1970: 1ms net. (Horáček et al. 1979), 17.9.1988: 1 obs., 10.6.1992: 1ma net. (Horáček et al. 1995), 18.12.1991: 14s1, 13.2.1993: 4s1 (Uh et al.), 6.10.1993: 1ma, 2fa, 1fj net. (Zu et al.), 25.4.1994: 1fs net. (Uh), 16.2.1995: 5s1 (Ob et al.), 17.8.1995: 3mj, 1fj, 1ma net., 19.8.1995: 3mj, 2fa (Uh et al.), **39. Dmíca c.** (7588), 339 m: 2.2.1988: 2s1 (Ho et al.), 13.2.1993: 5s1, 15.2.1994: 3s1, 16.2.1995: 3s1 (Uh et al.), **40. Drienovská c.** (7391), 245 m: 22.4.1955: 7m, 5fcapt. (Vachold 1957, 1960), summer 1955: 2m, winter 1955/56: 20 ind. (Vachold 1957), 26.3.1956: 72m, 36f capt. (Vachold 1956), 26.6.1956: 14m, 13fcapt., 8.2.1957: 11m, 10fcapt., 14.2.1958: 3m capt. (Vachold 1960), 6.2.1958: 20 ind., 1.6.1959: 10 ind., 17.2.1961: 19 ind., 5.3.1963: 9 ind., 16.2.1968: 6 ind. (Gaisler & Hanák 1962, 1972), entrance part only: 1.3.1987: 4s1 (Danko & Mihók 1989), 25.4.1987: min 3–5 obs. det. (Horáček et al. 1995), 3.2.1988: 3s1 (Ho et al.), 25.2.1993: 57s1 (Fu et al.), 16.2.1994: 6s1 (Pa), 9.2.1995: 12s1 (Fu et al.), **41. Erňa c.** (7391), 500 m: 3.8.1980: 1ms, 1net. (Horáček & Červený 1984, Horáček et al. 1995), 3.5.1990: 1s1 obs. (Horáček et al. 1995), 22.12.1993: 3s1, 16.2.1994: 3s1, 8.2.1995: 3s1, 17.2.1995: 3s1 (Uh et al.), 16.2.1994: 1 ind., food *S. aluco* (Ob), **42. Hačavská c.** (7391), 800 m: 15.1.1992: 1s1, 14.2.1993: 2s1 (Uh et al.), **43. Hámořská c.** (7488), 300 m: 23–27.4.1987: 1–2s1 obs. (Horáček et al. 1995), **44. Hrušov** (7489), ca 400 m: small cave: 9.3.1994: 2s1, gallery near tunnel: 9.3.1994: 5s1 (Fu), **45. Jasov** lofts of monastery (7391), 280 m: 2.8.1980: 5 obs., 13.6.1992: 3s1 in colony of *R. euryale* (Horáček et al. 1995), 29.8.1994: 1 ind. dead (Pa, Na), **46. Jasovská c.** (7391), 256 m: winter 1954/55: 51f, 71m capt., summer 1955, winter 1955/56: 87f, 142m (Vachold 1957), 19.4.1955: 260 ind., 19.10.1955: 74 obs. (Vachold 1956), 12.7.1955: 91m, 51fcapt., 9.11.1955: 132m, 116fcapt., 26.3.1956: 118m, 93fcapt., 26.6.1956: 110m, 92fcapt., 5.2.1957: 128m, 130fcapt., 14.2.1958: 81m, 70fcapt. (Vachold 1960), 8.12.1956: 50 ind., 3.3.1964: 77 ind., 23.5.1965: 2 ind., 16.2.1968: 43 ind., 14.2.1969: 203 ind., 4.2.1970: 133 ind. (Gaisler & Hanák 1972), 1.8.1980: 1 obs. (Horáček & Červený 1984, Horáček et al. 1995), 12.2.1984: several ind. (Danko & Mihók 1989), 13.6.1992: 1fa net. (Horáček et al. 1995), 22.2.1979: 83s1, 9.1.1982: 80s1, 21.2.1980: 83s1 (Ho), 22.3.1986: 87s1 (Fu), 19.3.1987: 121s1 (Ho), 3.2.1988: 75s1 (Ho et al.), 8.1.1992: 9s1 (Uh), 22.1.1993: 78s1 (Fu), 12.2.1993: 271s1, 25.2.1994: 210s1, 26.2.1994: 212s1, 5.4.1994: 76s1, 8.10.1994: 147s1, 23.10.1994: 138s1, 30.10.1994: 136s1, 27.11.1994: 185s1, 14.12.1994: 208s1, 30.12.1994: 216s1, 14.1.1995: 239s1, 29.1.1995: 236s1, 12.2.1995: 256s1, 25.2.1995: 258s1, 12.3.1995: 250s1, 29.3.1995: 257s1, 9.4.1995: 172s1, 13.5.1995: 71s1 (Fulin 1995), upper entrance: 29.8.1994: 8s1 (Pa, Na), **47. Kečovo**, **Nad vyvie-račkou c.** (7588), 450 m: 23.10.1991: 1s1 (Uh), **48. Krásnohorská c.** (7389), 305 m: 4.12.1993: 6s1 (Ta), **49. Krásnohorská Dlhá Lúka** (7389), 315 m: loft of school: 14.8.1974: 200 obs.: 2fa, 2fj, 2mj capt. (Horáček et al. 1979, Horáček & Zima 1979), 15.8.1974: 200 obs.: 13fa, 1fs, 18fj, 16mj capt., 5.8.1975: 200 obs., 4.8.1977: 1fa, 1fj (Horáček et al. 1979), 13.5.1983: 4–5s1 obs. (Horáček et al. 1995), loft of church tower: 29.5.1980: colony 50–80 ind.: 2fa, 28.6.1981: colony 250 ind.: 3fa, 3j, 27.6.1982: colony 250–fG (without juv.) (Horáček & Červený 1984, Horáček et al. 1995), 13.5.1983: 8s1, 3 dead ind. (after *Tyto alba*?); cemetery: 28.6.1981: 2fa1net. (Horáček et al. 1995), **50. Liščí diera c.** (7588), 373 m: 13.8.1970: 2ms net., 3.8.1977: 4ma net. (Horáček et al. 1979), 27.6.1981: 1ms net., 10.6.1992: 1ma net. (Horáček et al. 1995), 20.2.1980: 1s1, 23.2.1979: 4s1, 2.2.1988: 3s1, 11.6.1992: net. (Ho et al.), 6.10.1993: 7ma, 2ms, 2fa net. (Zu et al.), 28.11.1993: 4s1 (Uh), 16.2.1995: 5s1 (Ob et al.), 17.8.1995: 1fa, 1fj, 1s1, 1mj net., 18.8.1995: 1fa, 3ma, 1fs, 1fj, 1mj net., 19.8.1995: 2mj, 1ma, 1fj net. (Uh et al.), **51. Ľudmila c.** (7488), 249 m: 11.12.1956: 3 ind. (Gaisler & Hanák 1972), 9.2.1957: 2m capt. (Vachold 1960), April 1957: 3m, 6fcapt. (Štollmann & Dudich 1985), **52. Majkova diera c.** (7489), 459 m: 10.8.1970: 1ms net. (Horáček et al. 1979), 2.2.1988: 4s1 (Ho et al.), 3.1.1992: 2s1, 14.2.1993: 3s1, 16.2.1994: 4s1, 17.2.1995: 5s1 (Uh et al.), **53. Marciho c.** (7390), 852 m: 22.2.1952: 1 ind. (Mošanský 1957, 1980), 28.3.1956: 2m capt. (Vachold

1960), 29.2.1992: 2si, 14.11.1992: 1si (Uh), 8.2.1995: 2si (Pa et al.), 54. Mašťal'ná c. (7488), 550 m: 30.8.1982: 1 obs (Horáček et al. 1995), 55. Milada (7488), 420 m: 3.2.1970: 2 ind (Gaisler & Hanák 1972), 17.9.1988: 4 obs., 11.6.1992: 1ma net. (Horáček et al. 1995), 2.2.1988: 17si (Ho et al.), 21.2.1992: 20si, 13.2.1993: 54si, 15.2.1994: 30si (Uh et al.), 17.2.1995: 61si (Ob et al.), 30.5.1995: 1ma net. (Uh, Bc), 56. Moldavská c. (7391), 220 m: 1.8.1980: 2 ms (Horáček & Červený 1984, Horáček et al. 1995), 10.3.1993: 2si (Fu), 9.1.1982: 2si (Ho), 27.2.1994: 3si (Fu), lower part: 3.2.1988: 1si (Ho et al.), upper part: 27.2.1995: 2si (Fu), 57. Silická Jablonica (7489), 256 m: loft of cath. church: 24.7.1978: 1 obs., 21.5.1980: 2si, loft of evang. church: 24.7.1978: 130 obs.: 1fa, 1fs, 1ma capt., 24.7.1979: 80 obs.: 1ma, 1fs, 22.6.1979: 50 obs.: 2ma, 4ms, 17faG, 6fs capt., 21.5.1980: 40 obs., 29.5.1980: 40 obs.: 2fa, 3fs, loft of barracks: 14.8.1986: colony 80–100 obs. (Horáček et al. 1979, 1995, Horáček & Červený 1984, Horáček & Zima 1979), 58. Slaninová c. (7391), 650 m: 26.4.1987: 2 obs (Horáček et al. 1995), 59. Stará Domica c. (7588), 340 m: 30.5.1954: 1m capt. (Vachold 1955, Šebek 1956), 5.5.1954: 2m, 1fcapt., 12.10.1954: 1m capt., 15.11.1955: 1m, 1fcapt., 14.3.1956: 3m, 1fcapt., 28.6.1956: 1m capt., 7.2.1957: 4m, 2fcapt., 30.11.1957: 2m capt., 16.2.1958: 4m, 1fcapt. (Vachold 1960), 23.2.1979: 2si, 20.2.1980: 1si, 9.1.1982: 7si, 2.2.1988: 3si (Ho et al.), 60. Zbojnica c. (7489), 380 m: 26.10.1981: 1ind., food of *S. aluco*, 19.9.1991: 1ind., food of *S. aluco* (Obuch 1985c, 1994), 6.9.1982: 1 obs., 2.5.1990: 1si (Horáček et al. 1995), 61. Zvonivá jama, abyss (7388), 670 m: 13.5.1983: 1ma net., 5si (Horáček et al. 1995).

Volovské vrchy Mts (070)

62. Košická Belá, Pod Širokým hrbkom gallery (7292), 585 m: 31.1.1982: 1ind., 8.1.1984: 1ind., 13.1.1985: 1ind., 1.2.1986: 1ind. (Danko & Mihók 1989), 28.1.1995: 1si (Da), 63. Perlová valley, Tokáreň (7191), 800 m: 28.12.1993: 1si (Pačnovský 1995), 27.12.1994: 1si (Pa), 64. Šarkanova díra c. (7190), 860 m: 26.2.1995: 1si (Da).

Čierna Hora Mts (080)

65. V Kysaku c. (7193), 298 m: 3.11.1960: 12 ind (Palášthy & Olejár 1963), 1.2.1987: 2 ind (Danko & Mihók 1989), 6.2.1994: 1si (Pa et al.), 66. Malý Ružinok valley, small cave (7192), 650 m: Nov. 1992: 1si (Ta), 67. Sokol-Biela skala, Krížová c. (7193), 800 m: 7.3.1987: 1ind (Danko & Mihók 1989), 68. Veľká Lodina, V Humenci c. (7193), 420 m: 6.12.1958, 1.5.1975 (Mošanský 1980), 69. Veľká Ružinská c. (7192), 614 m: 6.1.1995: 1si (Pa),

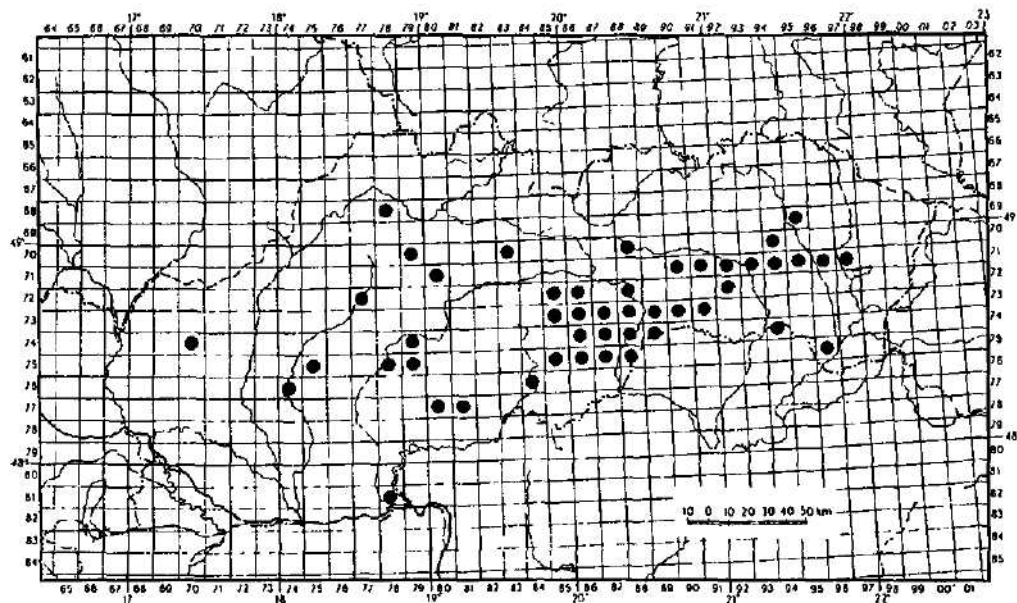


Fig. 1A. Distributional patterns of *Rhinolophus ferrumequinum* in Slovakia: all records shown in the Slovak fauna mapping grid (10.2x11.2 km).

Malé Karpaty Mts. (090)

70. Driny c. (7470), 360 m, 14.2.1984: 1 ind. (Muškovič 1987, 1993).

Tribeč Mts. (110)

71. Gýmeš, cellar (7575), 514 m, 1.7.1966: 1 ind. (Gaisler & Hanák 1972), 10.4.1968: 1 ind., 5.7.1969: 2 ind. (Lagač 1986).

Strážovské vrchy Mts. (120)

72. Skalky, 3 caves (6878), 530 m, 14.12.1980: 1 si (Ob).

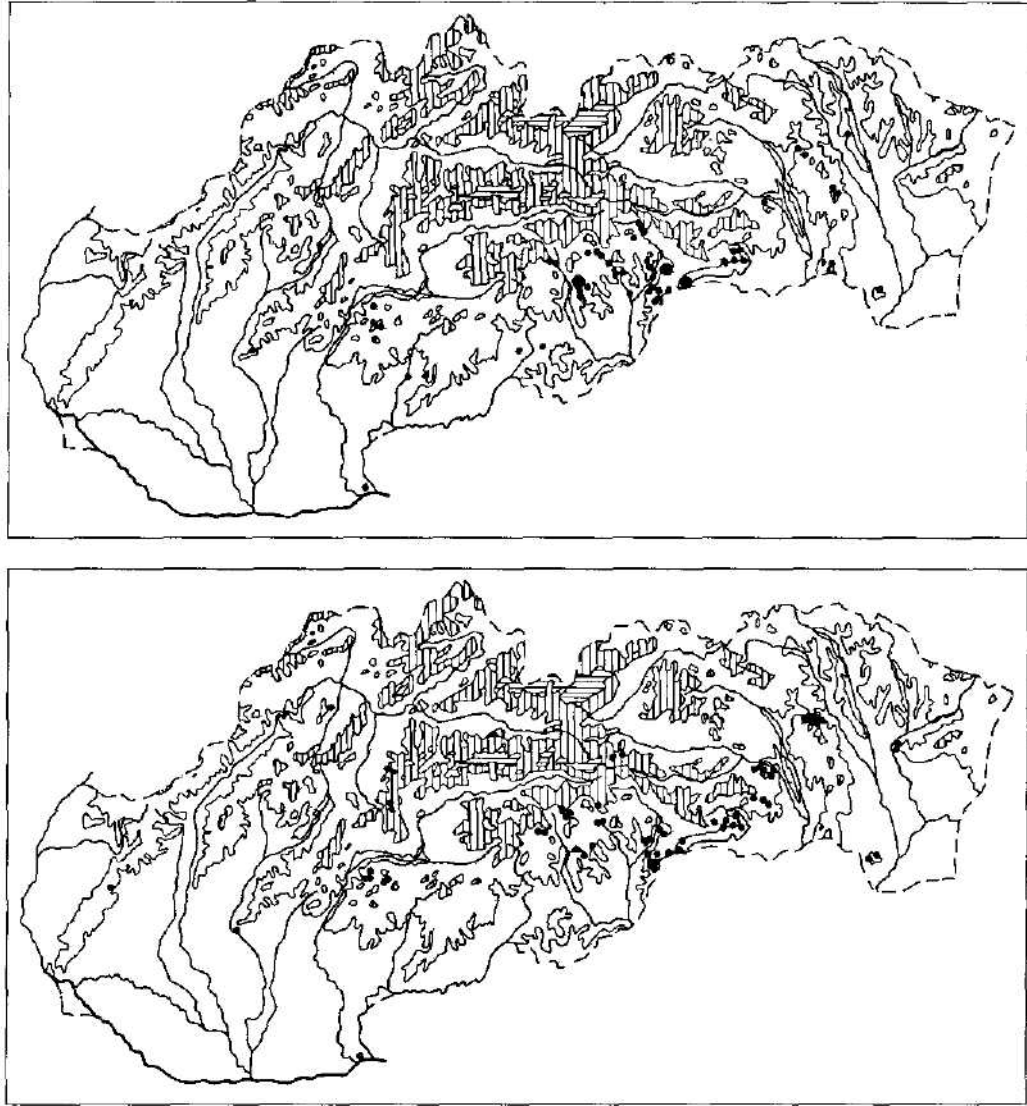


Fig. 1B. Distributional patterns of *Rhinolophus ferrumequinum* in Slovakia. above – summer records: nursery colonies (large dots), other records (small dots); below – winter records (dots) and osteological records (triangles)

Veľká Fatra Mts (150)

73. Dolná Tufňa c. (7180), 950 m 13 2 1961 1 ind, **74. Harmanecká c.** (7180), 826 m 10 3 1966 2 ind (Gaisler & Hanák 1972), 4 3 1964 1ma capt (Štolmann 1968a), **75. Mažarná c.** (7079), 800m 25 2 1969 1ma capt (Darola & Obuch 1980, Svatoň 1971), Dec 1982 1 ind, **76. Piesočná c.** (7079), 800 m 22 12 1972 1 ind (Obuch 1983), 7 3 1974 1 ind (Darola & Obuch 1980, Obuch 1983)

Nízke Tatry Mts (190)

77. Beníkova c. (7083), 908 m dat ? thanat (Rybář 1980)

Hornotatranská kotlina basin (230)

78. Bojnice, cellar (7277), 290 m 1 9 1954 1 ind (Brtek & Vachold 1962, Vachol 1955, 1960, Šebek 1956)

Štiavnické vrchy Mts (300)

79. Banská Štiavnica, loft of church (7579), 600 m 17 9 1954 3 ind (Vachold 1955, 1956, 1960, Šebek 1956), **80. Bukovec**, gallery (7479), 510 m 16 12 1983 1st, **82. Floriánka** gallery (7578), 770 m 16 3 1984 2st, 11 1 1994 3st, 27 1 1995 3st (Uhrin et al 1995), **83. Hodruša** (7578), 300m July 1954 5 ind (Gaisler 1956, Šebek 1956), **84. Hodruša-Majer**, (7578), 440 m 11 1 1989 (Farbiak 1989), **85. Ignác** gallery (7579), 590 m 13 3 1984 1st, 23 3 1984 1st, 31 3 1984 3st, 5 2 1986 2st, 21 2 1986 2st, 11 1 1989 1st, 10 1 1994 2st, 26 1 1995 3st, **86. Schopfer mine** (7579), 320 m 21 2 1995 136st (Uhrin et al 1995), **87. Sklené Teplice**, loft of church (7479), 360 m 15 9 1954 2m (Vachold 1955, 1956, 1960, Šebek 1956)

Krupinská planina Mts (350)

88. Medovarce (7780), 400 m 21 4 1954 1m capt (Vachold 1960, Šebek 1956)

Žiarska kotlina basin (380)

89. Čabrad, cellar (7781), 300 m 18 7 1954 1 ind (Vachold 1960)

Lučenská kotlina basin (392)

90. Lučenec (7684), 190 m June 1877, May 1883 (Maleševic 1892)

Rimavská kotlina basin (393)

91. Pesko c. (7588), 210 m 27 6 1982 1st obs (Horáček & Červený 1984, Horáček et al 1995),

Burda Mts (420)

92. Kováčovské kopce galleries (8178), 380 m 15 4 1958 2 ind, 12 11 1958 1 ind (Gaisler & Hanák 1972), 15 10 1955 (Vachold 1960)

Slanske vrchy Mts (440)

93. Banské loft (7195), 350 m 2 6 1993 1 obs, **94. Cabov** loft (7195), 210 m 2 6 1993 1 obs, 18 10 1994 1 obs (Pjenčák 1995), **95. Červenica** (7194), 466 m 19 6 1970 1 ind (Palášthy 1987), loft May–Aug 1970 43 obs (Palášthy 1971), **96. Dubník** small gallery (7094), 650 m 31 1 1987 1st (Danko & Mihok 1989), 700 m, gallery no 4 19 2 1992 1st, 1 2 1994 1st (Da), gallery no 7 6 12 1993 1st, 1 2 1994 1st (Pj), 21 galleries Feb 1994 3st, **97. Leštiny**, mine (7094), 625 m Feb 1994 14st (Da et al), **98. Libanka** small gallery (7094), 700 m 28 2 1987 1 ind (Danko & Mihok 1989), **99. Libanka**, mine (7094), 625 m 25 1 1962, 22 2 1962 and 7 3 1962 9 ind (Palášthy & Olejar 1963), 10 3 1985 2 ind, 22 2 1986 3 ind, Jan–Feb 1987 8 ind (Danko & Mihok 1989), 6 1–12 3 1988 9st, 29 1–12 3 1990 14st, 8 2 1 3 1994 5st, Jan 1995 23st, part Apolonia 10 12 1992 1st, 6 3 1993 1st, 6 12 1994 1st (Da et al), **100. Malá Šimonka**, mine (7094), 880 m 14 3 1987 1 ind (Danko & Mihok 1989), upper part only 28 1 1993 2st (Da), **101. Slanská Huta**, military bunker (7494), 525 m 17 7 1964 (Mošanský 1980), **102. Zamutov** (7094), 460 m, galleries 6 3 1994 10 12 1994 1st (Pjenčák 1995), **103. Žehňa**, loft (7094), 426 m May–Aug 1970 1 obs (Palášthy 1971)

Zemplínske vrchy Mts (450)

104. Kašov, cellar (7596), 180 m 3 4 1983 4f, 26 11 1983 11 ind, 7 1 1984 15 ind, 13 3 1984 16 ind, 26 1 1985 6 ind, 4 2 1986 6 ind, 17 1 1987 5 ind, 20 2 1988 5st, 16 3 1989 4st, 13 2 1990 5st, 29 1 1991 5st, 2 2 1992 5st, 24 1 1993 10st, 3 2 1994 14st, 13 9 1994 2 torpid, 1m, 1f net (Da), **105. Veľká Tŕňa**, cellar (7596), 178 m 17 1 1984 1 ind (Danko & Mihok 1989)

Vihorlat Mts (710)

106. Brekov, cave (7196), 250 m Jan 1988 1f (Th), **107. Strážske-Krivošťany**, gallery (7197), 250 m 22 2 1989 1f (Da), 1 11 1989 1st, 24 10 1990 1st (Th)

Ondavská vrchovina Mts (740)

108. Detrik loft of church (6995), 340 29 6 1995 1 obs (Pjenčák 1995)

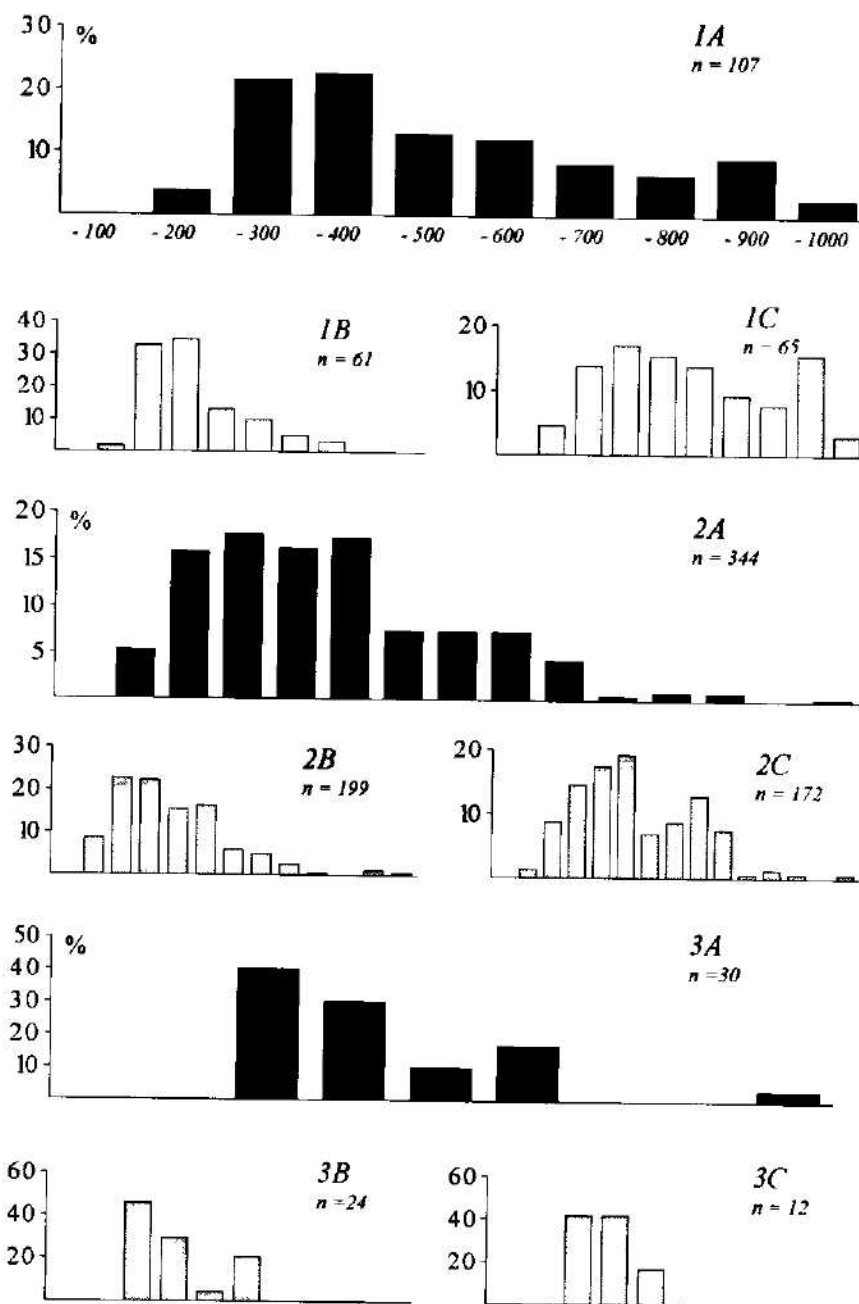


Fig 4 Vertical distribution of occurrence localities of horseshoe bats in Slovakia (A – all localities, incl. osteological findings, B – summer records, C – winter records, 1 – *Rhinolophus ferrumequinum*, 2 – *R. hipposideros*, 3 – *R. euryale*)

Nitrianska pahorkatina Mts (802)

109. Nitra, cellar (7674), 190 m 15.11.1967 1 ind (Ligač 1986)

Without complete data, unclear and unvalid findings

Slovenský kras Mts Jasovská cave (7391), 256 m 1937 (Šebek 1956), Strážovské vrchy Mts Slatinka n. Bebravou (7175), 290 m dat ? (Brtek & Vachold 1962), Liptovská kotlina basin Liskovská c. (6982), 500 m dat ? (Gaisler & Hanák 1972, 1973), Borská nížina lowland Malacky (7586), 159 m dat ? (Jirsík 1925, Šebek 1956, Gaisler 1956), Trnavská pahorkatina Mts Báhoň (7670), cca 200m dat ? (Jirsík 1925, Šebek 1956, Gaisler 1956)

Distribution

The earliest record of *R. ferrumequinum* in Slovakia comes from Lučenec, southern Slovakia (Maleševics 1892). Until now, the greater horseshoe bat has been recorded in Slovakia in 110 localities, representing 24 orographical units (Fig. 1) and approximately 11.1% of territory of Slovakia.

Thanks to relatively rich record, it seems possible to distinguish the regions of permanent occurrence from those in which the subjected species occurred only accidentally. The former include the south and middle part of central and Eastern Slovakia, viz., Muránska planina Mts, Revúcka vrchovina Mts, Slovenský kras Mts and Slanské vrchy Mts. Most localities come from Slovenský kras (28), karst regions of Revúcka vrchovina Mts (18), Muránska planina Mts (11) and from abandoned mines and galleries in Slanské vrchy Mts (11). In the other regions, only solitary individuals were observed, mostly during the winter period (e.g. Košel 1976, Štollmann 1968, Danko & Mihok 1989, Mošanský 1980, Palášthy & Olejár 1963, Ligač 1986, Vachold 1960, Gaisler & Hanák 1972, Pačenovský 1995, orig. data). It concerns also all karst regions in the western part of Slovakia. In Czech Republic this species does not occur, except for few irregular winter records, mostly in the Moravian karst (Gaisler et al. 1988, Hanák et al. 1995). The western-most record in Slovakia is that of one individual hibernating in Driny cave in Malé Karpaty Mts in 1984 (Mutkovič 1987, 1993). Most of the other records from western Slovakia refer to old literary data that often provided no details (cf. Gaisler 1956, Brtek & Vachold 1962). The northern marginal record comes from a small cave Skalky in Strážovské vrchy Mts (14 Dec 1980 – 1 ind.). The species occurrence further north is not probable. In Poland this species was recorded only three times during the hibernation period (Woloszyn 1994). In Slovakia, the lowland regions are not colonized, and, so far, only one record is available in the East Slovakian Lowland (Horáček & Červený 1984).

Vertical distribution (Fig. 4) of this species is characterized with that the most of localities (56.8%) lie in range 200–500 m a.s.l., though the overall range is 178 to 950 m. Summer records come from altitudes of 100 to 800 m, the winter records are dispersed throughout whole the range of the vertical distribution of this species in Slovakia.

Ecological notes

Out of 64 hibernacula, 43 (66.2%) are natural caves, 16 (24.6%) are old mines and galleries, 4 are cellars (6.2%) and one hibernacula is an abandoned railway tunnel (1.5%). In one case an active individual was observed in the late autumn period (18 Oct. 1994) in a church loft (Cabov village, Pjenčák 1995). The number of individuals observed in hibernacula at one control varied from 1 to 271, with 32.4 on average ($n=208$ controls). Winter colonies of this species were found only in three localities in Slovenský kras Mts: Drienovská cave, Jasovská cave and Milada cave. The changes of abundance of *R. ferrumequinum* in Jasovská cave during winter were studied by Fulín (1995).

In summer and during transient periods (15 Apr – 14 Oct), this species was recorded in lofts of churches (35 records, 29.6%), in lofts of the other types buildings (houses, castles, monasteries) (10 records, 8.4%), 20 times the species was observed or detected inside caves (16.8%), 4

times inside cellars (3.4%), 2 times inside galleries (1.7%) and once in a military bunker (0.8%). The species was netted or captured 43 times inside or in front of caves (36.1%), once in a cellar (0.8%), once in cemetery (0.8%), once it was found dead on the road and once observed and detected nearby a small stream. Several times in the summer period torpid individuals were found in caves (e. g. 2 May 1993 in Brestová cave). Except for one in Revúcka vrchovina Mts. (Lipovec, loft of church: 50 ind.), the nursery colonies were found only in Slovenský kras Mts., viz. in 4 localities: Drienovská cave, Jasovská cave and in Krásnohorská Dlhá Lúka (2 buildings) and Silická Jablonica (2 buildings). A colony in Silická Jablonica was confirmed also in 1995 (250–300 ind.) (Matis in litt.). The record in Lipovec contradicts the previous statements (Mošanský 1980, Horáček et al. 1979) that breeding colonies in Slovakia are restricted to the territory of Slovenský kras Mts. (cf. also Horáček & Červený 1984). The recent data suggest that the Slovak population of this species maintain its synanthropic roosting strategy as discussed earlier by Horáček & Zima (1979). The number of individuals in loft roosting colonies varied from 50 to 250 (124.6 ind. per one check, $n=13$ checks). Summer colonies in caves were not recently confirmed. In other regions, only solitary individuals were observed in loft spaces.

In total, 77 individuals were netted in May–October period. This sample was dominated by males (72.9%: 29ma, 13ms, 11mj, 1m), the female sample (27.1%) was as follow: 12fa, 2fs, 5fj, 1f.

The record of the species in owl pellets is scarce: 3 individuals in recent food of *S. aluco* (Zbojnická cave, Erňa cave in Slovenský kras Mts.) and 1 individual in recent pellets of *T. alba* (Lipovec, church in Revúcka vrchovina Mts.) (Obuch 1985a, Uhrin & Benda 1995).

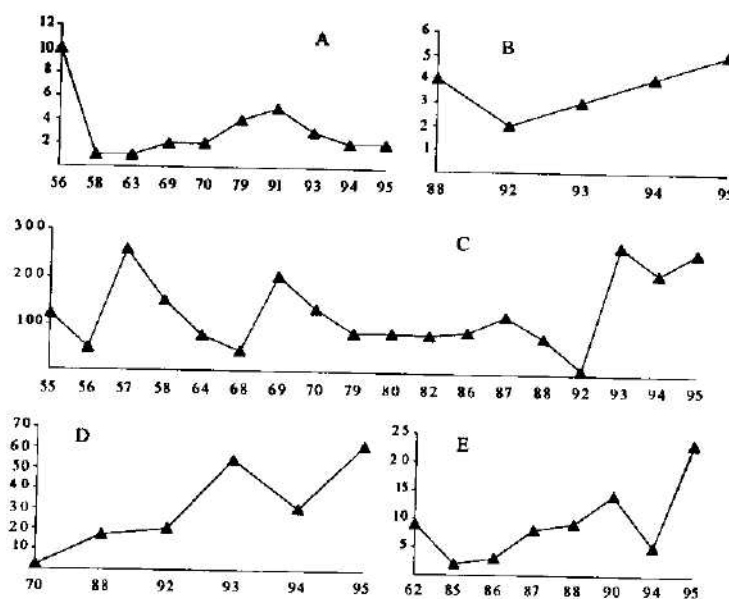


Fig. 5. Changes in abundance of *Rhinolophus ferrumequinum* in some hibernacula: A – Ardovská cave, B – Majkova cave, C – Jasovská cave, D – Milada cave, E – Libanka cave.

Changes in numbers

The longest row of abundance data comes from Jasovská cave in Slovenský kras Mts. (Fig. 5C). Despite of irregular yearly variations (see also Uhrin 1993b), the abundance seems stable in a long-time respect. The data from other localities in this region have revealed the similar situation or even the number of this species in winter places seem to increase. For discussion of such oscillations see Horáček (1984). A similar is also a situation in Libanka mine in Slanské vrchy Mts., which exact interpretation is complicated due to the fact that the checks were not made in the same parts of this large hibernacula in each of years.

From 90 individuals of *R. ferrumequinum* banded during the recent study period, we obtained records of movements from hibernacula to transient roosts, between hibernacula and from a nursery colony in Hungary to winter roost in Slovakia, in addition to a repeat records from one hibernaculum (Kašov cellar). A longevity records concerns a 22 years old individual found in Jasovská cave. Our results corresponded to previous data from Slovakia (Gaisler & Hanák 1969a, b). These authors wrote that the longest movement was 29 km. Our data documented movement 80 km long from hibernacula in Dubník mine to Mád in Hungary (see also Bihari 1995).

37040	banded 06.02.1973 checked 20.04.1986	– Jasovská cave, – Mád (Hungary), 13 years, 2 months, 60 km SSE
90500	banded 16.09.1980 checked 12.03.1988	– Kašov, cellar, fa (Hanák) – Dubník, Libanka mine, 7 years, 6 months, 50 km NNW (Da)
Z 634777	banded 17.01.1984 checked 03.02.1994	– Kašov, cellar (Da) – ibidem, 10 years, 1 months (Da)
Z 634548	banded 17.01.1984 checked 20.02.1988 checked 29.01.1991	– Kašov, cell – Brehov, cellar 4 years, 1 month, 6 km E (Da) – Kašov, cellar, 11 years (Da)
Z 659280	banded 17.01.1987 checked 03.04.1988	– Kašov, cellar, female (Da) – Mád (Hungary), 45 km SW (Topál)
Z 659378	banded 31.01.1987 checked 09.04.1988	– Dubník, Libanka, mine, female, (Da) – Mád (Hungary), 80 km S (Topál)
Z 653800	banded 22.02.1986 checked ibidem in winter 1987, 1988, 1990 (Da)	– Dubník, Libanka mine, male (Da)
Z 659282	banded 17.01.1987 checked ibidem in 1987, 1988, 1990	– Kašov, cellar, female (Da)
Y 13220	banded 03.03.1964 checked 22.03.1986	– Jasovská cave, ad. male (Hanák) – ibidem, 22 years (Fulín)
Z 719829	banded 06.10.1993 checked 15.02.1994	– Liščia diara cave, ad. female (Uh) – Milada cave, 5,5 km N (Uh)
Mus. Bud. 50392	banded 18.10.1990 checked 14.11.1991	– Baradla cave (Topál?) – Ardovská cave, 10 km NW (Uh)
Mus. Bud. 54088	banded 24.07.1992	– Bodrogkőcsztur, nursery colony, female (Dobrosi)
X 10234 ma	checked 25.02.1993 banded 02.05.1993 checked 01.09.1994	– Drienovecká cave, 57,5 km NNW (Uh) – Brestová cave, ad. male (Uh) – ibidem (Uh)

Rhinolophus hipposideros (Bechstein, 1800)

Survey of the records

Veporské vrchy Mts (010)

1. **Hámor** (7485), 300 m, loft of gamekeepers cottage: July 1981 (Grimmberger & Wilhelm 1985).

Muránska planina Mts (021)

2. **Bobačka c.** (7286), 770 m: 15.2.1975: 14si, 20.2.1979: 6si (Hanák & Anděra 1980), 4.2.1988: 9si, 5.2.1988: 23si (Ho et al.), lower part: 23.1.1993: 8si, 27.11.1994: 11si, 14.2.1995: 19si (Uh et al.), upper part: 7.1.1982: 29si (Ho), 7.3.1993: 54si, 7.10.1993: 1fs, 1si net, 6.2.1994: 55si, 19.9.1994: 1fs, 2ms, 1ma net (Uh et al.), 6.10.1994: 5si (Ko), 27.11.1994: 57si, 15.2.1995: 56si (Uh et al.). 3. **Brestová c.** (7286), 550 m: 17.7.1978: 1ma net. (Horáček et al. 1979), 17.7.1978: 1ma net, 7.6.1995: 1det., net. (Horáček et al. 1995), 23.12.1992: 9si, 17.2.1993: 9si, 1.4.1993: 9si, 2.5.1993: 2si net, 18.4.1993: 2ma net, 19.5.1993: 2ma, 2m net., 23.11.1993: 16si, 23.12.1993: 7si, 7.2.1994: 16si, 23.4.1994: 2si torpid, 1si aktiv., 2ms net, 22.5.1994: 2torpid, 1.9.1994: 1ma net., 8.12.1994: 18si, 1.2.1995: 14si (Uh), 6.6.1995: 1torpid, 7.6.1995: 1det. (Ho), 25.7.1995: 1det (Uh). 4. **Čertova c.** (7285), 650 m: 9.12.1992: 57si, 3.12.1993: 56si, 18.11.1994: 41si. 5. **Dr. Haninca c.** (7286), 900–1000 m: 18.2.1993: 3si (Uh). 6. **Falúčkova c. near Tisovec** (7385), ca 550 m: 29.7.1970: 1m net (Horáček et al. 1979), 15.2.1975: 9si (Hanák & Anděra 1980). 7. **Hradová** (7385), 700–800 m, cave: 22.9.1980: 2si (Darola et al. 1985), abyss: 3 ind., thanat.: 24.6.1980 (Obuch 1985a, b). 8. **Hrdzavá** loft of forest cottage (7286), 750 m: 6.6.1995: 1si. 9. **Husleho c.** (7285), 520 m: 20.2.1993: 42si, Jan. 1995: 32si. 10. **Husleho c. II.** (7285), 510 m: 8.12.1994: 8si (Uh et al.). 11. **Javorníková valley**, small c. (7286), ca 600 m: 15.5.1978: 1si (Darola et al. 1985). 12. **Javorníková valley** (7286), ca 700 m: 6.4.1979: 1 ind., food of *S. aluco* (Obuch 1985a, b), ca 700 m, cave no 19: 28.1.1993: 7si, 20.11.1994: 1si (Uh). 13. **Jazerná c.** (7285), 483 m, winter 1954/55: 9 ind (Vachold 1955), 2.2.1988: 46si (Ha), entrance part only: 30.1.1993: 2si (Uh). 14. **Jelenia priepasť c.** (7286), 1165 m: 9.2.1993: 3si (Uh). 15. **Klatná** (7285), 870 m, loft: 24.7.1974: 1m capt. (Bárta 1976). 16. **Klin c.** (7286), ca 500 m: 16.5.1978: 1si (Darola et al. 1985). 17. **Kostolík c.** (7385), 479 m: 3.2.1955: 650–700si: 39 capt. (Vachold 1955, 1960), 15.2.1961: 31 ind (Gaisler & Hanák 1972), 1.8.1972: 1ma net. (Horáček et al. 1979), 1.–6.2.1988: 23si (Ha), 19.1.1993: 69si, 6.11.1993: 19si (Uh), 18.2.1994: 20 ind., thanat. (Ob), 18.2.1994: 81si (Uh).

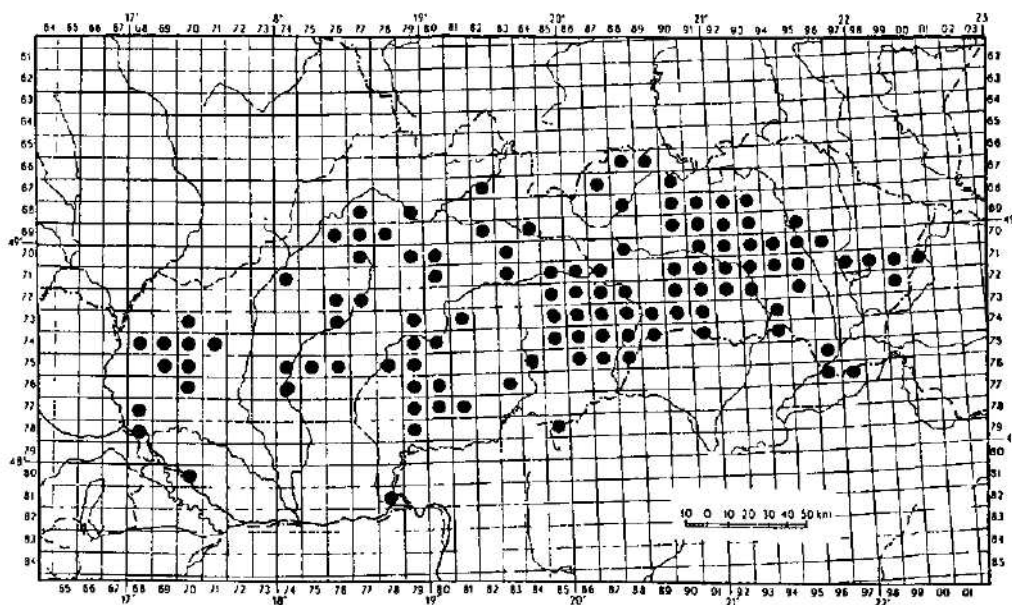


Fig. 2A. Distributional patterns of *Rhinolophus hipposideros* in Slovakia. For explanations see Fig. 1A.

et al.), thanat.: 20 ind. (Obuch 1995b), 29.1.1995: 81 si (Uh et al.), 18. Ladvianskeho c. (7186), 840 m: 15.2.1961: 1 ind. (Gaisler & Hanák 1972, Hanák & Anděra 1980), 1.8.1970: 4 si, 31.7.1972: 1 ma net. (Horáček et al. 1979), 10.2.1971: 5 si, 20.2.1979: 4 si (Hanák & Anděra 1980), 30.7.1980: 1 ms, 1 si net., 7.1.1982: 5 si, 4.2.1988: 7 si (Ho et al.), 7.1.1993: 8 si, 20.2.1993: 6 obs., 2.12.1993: 4 si, 13.8.1994: 4 ma, 1 ms net., 25.1.1995: 5 si, 4.6.1995: 2 m net., 10.12.1995: 1 si., 19. Malá v Brestovej c. (7286), 550 m: 23.12.1992: 1 si (Uh), 20. Malá Stožka c. (7285), 900 m: 4.4.1976: 3 si, 19.5.1976: 1 si (Darola et al. 1985), 21. Martincová c. (7285), 780 m: 5.2.1988: 3 si (Ho et al.), 4.11.1993: 1 si, 17.2.1994: 1 si (Uh et al.), cavity: 10.4.1979: 3 ind., food of *S. aluco* (Ob), 22. V Maši c. (7385), 410 m: 14.1.1993: 1 si (Uh), 23. Mašianske skalky (7186), 750 m: 1979: 2 ind., food of *S. aluco* (Ob), 24. Michňová c. (7385), 600 m: winter 1954/55: 148 ind. (Vachold 1955), 16.2.1961: 95 ind. (Gaisler & Hanák 1972), 26.4.1978: 6 si (Darola et al. 1985), 5.2.1988: 168 si (Ho et al.), 19.1.1993:

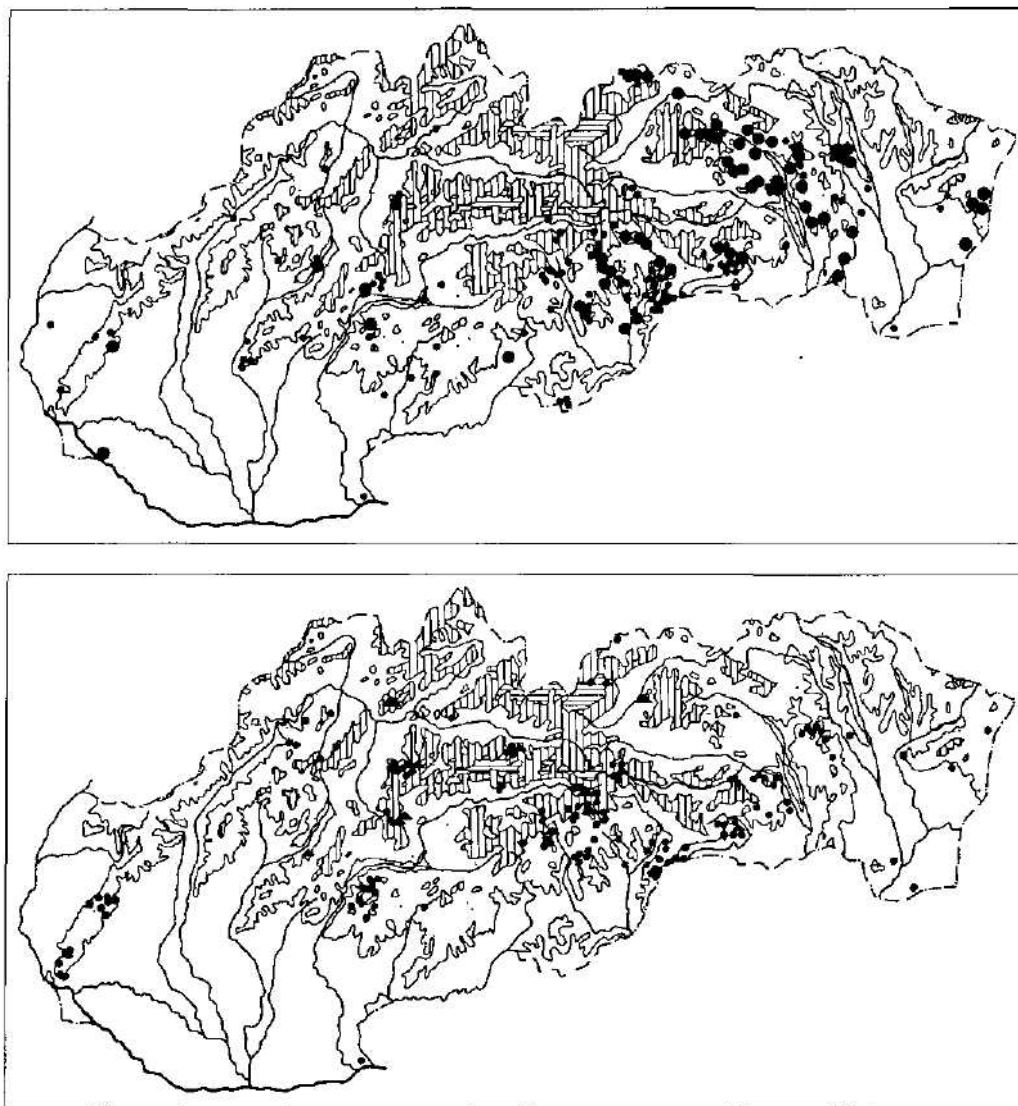


Fig. 2B. Distributional patterns of *Rhinolophus hipposideros* in Slovakia. For explanations see Fig. 1B.

155si, 19.2.1993: 184 obs., 6.11.1993: 51si, 18.2.1994: 179si, 29.1.1995: 223si, 28.12.1995: 181si, **25. Muráň castle** (7286), 900 m, loft of the cottage under castle 18.6.1994: 4 obs., **26. Nad Kamenným morom c.** (7285), 1200 m. 28.8.1994: 1si (Uh), **27. Netopierov c.** (7385), 589 m wnter 1954/55: 540si; 241 capt. (Vachold 1955), 16.2.1961: 456 ind. (Gaisler & Hanák 1972), 11.7.1981: 482 ind., thanat. (Obuch 1985b), 5.2.1988: 36si (Ho et al.), 14.1.1993: 20si, 6.11.1993: 11si, 18.2.1994: 53si, 29.1.1995: 61si (Uh et al.), **28. Na Osiskách c.** (7286), 530 m. 16.8.1974: 1 net., 7.6.1975: 6 obs. 2ma, 1fa net., 18.7.1978: 1ma net. (Horáček et al. 1979), 14.2.1975: 2 obs. (Hanák, Anděra 1980), 19.2.1993: 18si, 26.4.1993: 9ma, 3ms, 2fa net., 17.11.1993: 17si, 7.2.1994: 23si, 1m, 1.2.1995: 24si, **29. Pod Kl'akom c.** (7285), 1280 m. 23.1.1994: 1si (Uh), 27.10.1994: 2 ind., thanat. (Obuch 1995b, Obuch & Uhrin 1995), **30. Prandlovo c.** (7285), 560 m. 9.6.1975: 1si (Horáček et al. 1979), 30.1.1993: 17si, 4.11.1993: 12si (Uh), **31. Pri Štrbavej lebke c.** (7286), 780 m. 1.10.1994: 1si (Ko), **32. Šarkanica c.** (7285), 800 m. 15.6.1979: 1 ind., food of *S. aluco* (Obuch 1985a, c), 30.10.1981: 2si (Darola et al. 1985), 8.7.1991: 1 ind., food of *S. aluco*, 17.2.1994: 1 ind., food of *S. aluco* (Ob), 14.2.1995: 1si (Ob et al.), **33. Tisovec** (7385), 411 m. 2.3.1961: 2ma capt. (Stollmann 1968a), loft of church 1.8.1972: 1 obs. (Horáček et al. 1979), 17.8.1974: 1 obs. (Hanák & Anděra 1980), **34. Veľká rúťivá c.** (7286), 600 m. 11.7.1995: 5si obs., **35. Vlčia diera c.** (7286), 447 m. 28.1.1993: 2si, 20.11.1994: 4si (Uh).

Slovenský raj Mts. (022)

36. Čertova diera c. (7088) 700–800 m. 31.10.1994: 1si (Da), **37. Dobšínská ľadová c.** (7187), 971 m. dat? 1 ind., thanat. (Horáček 1976), 1975: 1 ind., thanat. (Ob), **38. Duča c.** (7187), 970 m. 14.2.1995: 1si (Uh et al.), thanat.: 7 ind. (Obuch 1995b), **39. Hajcov komin abyss** (7088), 640 m. 31.5.1968 (Mošanský 1980), **40. Medvedia c.** (7088), 914 m. 5.1.1974: 8si (Košel 1976), **41. Peklisko c.** (7088), ca 600 m. 11.7.1990: 3 ind., food of *S. aluco* (Obuch 1995), **42. Pod Hanišejom c.** (7187) 958 m. 15.2.1968: 2 ind. (Gaisler & Hanák 1972), **43. Prielom Hornádu, cavern** (7088), ca 600 m. 12.9.1959: 17 ind. (Gaisler & Hanák 1972, Gaisler 1963), **44. Stratenská c.** (7187), 1000 m. 15.2.1978: 78si (Ho), 15.2.1995: 3 ind., thanat. (Obuch 1995b)

Stolické vrchy Mts. (030)

45. Čuntava (7187), 1180 m, loft of cottage: 3.8.1994: 1 obs. (Uh et al.), **46. Muránska Huta** (7286), 703 m, loft of church 10.6.1975: 4 obs. (Horáček et al. 1979), **47. Za Borovou c.** (7385), ca 600 m. 31.1.1995: 3 si. (Uhrin & Benda 1995)

Revúcka vrchovina Mts. (040)

49. Betliar (7389), 341 m, loft of cath. church 6.5.1983: 1 torpid (Ho), 8.4.1989: 1 dead ind. (Horáček 1995), 4.8.1994: 20 obs. (Uhrin & Benda 1995, Uhrin et al. 1996), loft of castle: 6.5.1983: 40 obs., 28.4.1989: colony 70–80 (Horáček et al. 1995), **50. Budikovany, cellar** (7586), 240 m. 17.9.1954: 1ma capt. (Vachold 1960), **51. Drienčany, loft of church** (7586), 243 m. 9.8.1980: 1si (Horáček et al. 1995), 5.6.1995: 1 obs. (Uhrin & Benda 1995, Uhrin et al. 1996), **52. Henckovce, (7288), 360 m. loft of church: 1.8.1994: 1 obs., loft of another church: 1.8.1994: 7 obs., 53. Gočovo, loft of church** (7288), 380 m. 1.8.1994: 12 obs. (Uhrin et al. 1996), **54. Hostišovce, cellar** (7586), 270 m. 11.7.1955: 17f, 15j capt. (Vachold 1956), 16.10.1954: 7m, 10 f capt. (Vachold 1960), **55. Chvalovská c.** (7486), 250 m. 30.11.1994: 1si (Uhrin & Benda 1995, Uhrin et al. 1996), **56. Malá Drienčanská c.** (7586), 260 m. 23.2.1979: 3si, 10.1.1982: 7si, 1.2.1988: 2si (Ho et al.), 6.3.1993: 1si, **57. Kobeliarovo, loft of church** (7288), 481 m. 1.8.1994: 21, 12, 20 obs., **58. Mokrá Lúka, loft of church** (7386), 300 m. 20.6.1992: 30–40 obs. (Uhrin & Benda 1995, Uhrin et al. 1996), **59. Nandraž, (7387), 300 m. loft of church: 12.6.1975: 10–15 obs.: 2 capt. (Horáček et al. 1979), gallery: 17.2.1968 (Gaisler & Hanák 1972), 60. Nižné Valice, loft of castle** (7587), 220 m. 28.6.1982: colony 8 fG (Horáček et al. 1995), **61. Nováčany, loft of church** (7487), 280 m. 22.7.1995: 2 obs. (Uhrin & Benda 1995, Uhrin et al. 1996), **62. Ostrany, loft of castle** (7486), 300 m. 6.8.1980: 10 obs. (Horáček et al. 1995), loft of church tower: 5.6.1995: colony 19 obs., **63. Podbanište c.** (7486), 352 m. 30.11.1994: 7si, 23.2.1995: 8si activ., 31.5.1995: several obs. in entrance, 31.5.1995: 1sa, 2 faG net., **64. Pole Dúbravíc c.** (7486), 318 m. 23.2.1995: 4si (Uhrin & Benda 1995, Uhrin et al. 1996), **65. Pri Ridzoňovcoch c.** (7586), 335 m. 26.6.1982: 3 si. nct. (Horáček et al. 1995), 23.2.1995: 9si (Uhrin & Benda 1995, Uhrin et al. 1996), **66. Rudná, loft** (7388), 360 m. 10.8.1969: 1 obs. (Horáček et al. 1979), **67. Revúca** (7389), 318 m. Nov. 1894 (Méhely 1900, Topál 1954, Vachold 1960), ground-floor room of hospital. 11.9.1995: 1 activ. obs. (Uh), **68. Španie Pole, loft of church tower** (7486), 370 m. 5.6.1995: 2 obs., **69. Špaňopol'ská c.** (7486), 301 m. 30.11.1994: 29si, 23.2.1995: 31 si (Uhrin & Benda 1995, Uhrin et al. 1996), **70. Uhorské** (7584), 250 m, July 1986 (Steffens & Šteffek 1987), **71. V Drienku c.** (7486), 312 m. 30.11.1994: 26si, 23.2.1995: 9si (Uhrin & Benda 1995, Uhrin et al. 1996), **72. Veľká Drienčanská c.** (7586) 280 m. 17.9.1954: 2m capt., 18.1.1956: 1m capt. (Vachold 1960), 6.8.1980: 1ms, 1 fa net., 7.8.1980: 1ma, 7 fa, 8.8.1980: 1ma, 1 ms (Horáček et al. 1995), 1–6.2.1988: 2si (Ha), 23.2.1979: 5si, 10.2.1988: 2si (Ho), 6.3.1993: 2si, 30.11.1994: 14si, 23.2.1995: 9si, 1.6.1995: 1 torpid (Uhrin & Benda 1995, Uhrin et al. 1996), 2.6.1995 and 12.6.1995: 15 ind. thanat. (Obuch 1995b), **73. Veľký Blh, loft of castle** (7586), 216 m. 28.6.1982: 10 obs. fG (Horáček et al. 1995), **74. Vyšná Slaná, loft of church** (7287), 500 m. 2.8.1994: 20–30 obs. (Uhrin et al. 1996), **75. Vyšné Valice, loft of church** (7587), 240 m. 28.6.1982: 30–40 fG clustered (Horáček et al. 1995), **76. Zráz, gallery** (7386), 460 m. 13.12.1992: 36si (Uhrin & Benda 1995, Uhrin et al. 1996)

77. Ardovská c. (7488), 314 m. 14.10.1954: 2m, 1fcapt., 14.11.1955: 5m, 2fcapt., 18.3.1956: 1m capt., 28.6.1956: 5m, 4fcapt., 8.2.1957: 1m capt., 16.2.1958: 3m, 3fcapt. (Vachold 1960), 20.5.1965: 2 ind., 19.2.1968: 10 ind., 13.2.1969: 7 ind., 3.2.1970: 10 ind. (Gaisler & Hanák 1972), 22.2.1979: 25 obs.: 2 ma (Ho), 2.2.1988: 23 obs. (Ho et al.), 14.11.1991: 13si, 20.1.1993: 26si, 15.2.1994: 45si (Uh et al.), 16.2.1995: 36si (Ob et al.), **78. Bôrka**, loft of cath. church (7390), 564 m: 28.5.1980: 2si (Horáček et al. 1995), **79. Brzotín**, loft of church (7389), 260 m: 7.8.1969: 1 obs. (Horáček et al. 1979), 13.7.1992: 1 obs. (Uh), **80. Brzotínska c.** (7388), 270 m. 11.8.1965: 2 ind., 17.2.1968: 3 ind. (Gaisler & Hanák 1972), 5.8.1969: 1 obs., No. 1: 10.8.1974: 1si net, 11.8.1974: 1si net, No. 11: 11.8.1974: 1ma, 1fs, 2si net (Horáček et al. 1979), 13.2.1993: 3si, 16.2.1994: 3si (Uh et al.), 16.2.1995: 10si (Ob et al.), **81. Čertova díra c.** (7588), 370 m: 6.5.1954: 1m, 1fcapt., 28.1.1956: 1m capt. (Vachold 1960), 5.2.1958: 1 ind., 29.5.1959: 2 ind., 18.2.1968: 2 ind., 13.2.1969: 3 ind., 3.2.1970: 2 ind. (Gaisler & Hanák 1972), 12.8.1970: 1fs net, 13.6.1975: 1ma net. (Horáček et al. 1979), 17.9.1988: 1 si., 10.6.1992: 3 ma net. (Horáček et al. 1995), 20.2.1980: 6si (Ho), 18.12.1991: 20si, 13.2.1993: 29si (Uh et al.), 6.10.1993: 1ma net. (Zu et al.), 15.2.1994: 24si, 25.4.1994: 1ma, 1ms net., 17.8.1995: 5mj, 2fj, 1 net., 19.8.1995: 5mj, 1ma net. (Uh et al.), 21.9.1995: 2 torpid (Rci), 16.2.1995: 21si (Ob et al.), entrance hall only: 3si (Ho), **82. Domica c.** (7588), 339 m: 2.2.1988: 1si (Ho et al.), 14.11.1991: 3si, 28.11.1993: 2si, 22.12.1993: 4si, 13.2.1994: 4si, 15.2.1994: 23si (Uh et al.), 16.2.1995: 38si (Ob et al.), *thanat.* 1 ind. (Obuch 1995b), **83. Drienovská c.** (7391), 245 m: winter 1954/55: 18 ind., summer 1955: 1 ind., winter 1955/56: 2 ind., summer 1956: 1 ind. (Vachold 1957), 22.4.1955: 3m, 3fcapt., 19.3.1956: 9m, 8fcapt., 26.6.1956: 2m capt., 8.2.1957: 5m, 4fcapt., 14.2.1958: 3m, 4fcapt. (Vachold 1960), 6.2.1958: 1 ind., 1.6.1959: 5 ind., 17.2.1961: 9 ind., 5.3.1963: 5 ind., 22.5.1965: 5 ind., 16.2.1968: 20 ind. (Gaisler & Hanák 1962, 1972), 25.4.1987: 10 det. 1fs net (Horáček et al. 1995), entrance only: 1.3.1987: 2si (Danko & Mihók 1989), 3.2.1988: 3si (Ho et al.), 25.2.1993: 30si (Fu et al.), 16.2.1994: 27si, 9.2.1995: 25si (Pa et al.), **84. Erňa c.** (7391), 500 m: 3.8.1980: 1ms net (Horáček et al. 1995), 22.12.1993: 1si (Uh), 8.2.1995: 1si (Pa et al.), 22.9.1995: 1mj net., **85. Gemerskoteplická c.** (7387), 250 m: 19.9.1993: 1ma net (Uh), **86. Gombasecká c.** (7488), 249 m. 19.8.1955: 1 ind. (Gaisler & Hanák 1972), **87. Hačavská c.** (7391), 800 m. 7.2.1958: 2m (Gaisler & Hanák 1972, Hanák 1959), 25.7.1978: 1 net. (Horáček et al. 1979, 1995), 15.1.1992: 5si, 14.2.1993: 5si, 16.2.1994: 6si (Uh et al.), 8.2.1995: 4si (Pa et al.), **88. Hatiny** (7391), 200 m. 25.9.1977: 6 ind., food of *T. alba* (Obuch 1992, 1994), **89. Hámorská c.** (7488), 300 m: 23–24. 4.1987: 1torpid, 27.4.1987: 2torpid (Horáček et al. 1995), **90. Hrušov**, (7489), ca 400 m, small cave: 9.3.1994: 1si, gallery near tunnel: 9.3.1994: 1si (Fu), **91. Jasov**, (7391), 280 m, cellar of monastery: 23.3.1987: 4si (Danko & Mihók 1989), lofts of monastery: 2.8.1980: colony 20–30 ind., 13.6.1992: colony 16 ind. (Horáček et al. 1995), 29.8.1994: 11si (Pa, Na), **92. Jasovská c.** (7391), 256 m: winter 1954/55: 17 ind., summer 1955: 7 ind., winter 1955/56: 32 ind., summer 1956: 27 ind. (Vachold 1957), 12.3.1956: 2 capt. (Vachold 1956), 19.4.1955: 5m, 3fcapt., 18.7.1955: 2m capt., 9.11.1955: 3m, 3fcapt., 26.3.1956: 8m, 9fcapt., 26.6.1956: 3m capt., 5.2.1957: 8m, 7fcapt., 14.2.1958: 8m, 7fcapt. (Vachold 1960), 8.12.1956: 20 ind., 3.3.1964: 23.5.1965: 2 ind., 16.2.1968: 50 ind., 14.2.1969: 70 ind., 4.2.1970: 50 ind. (Gaisler & Hanák 1972), 22.2.1979: 43si, 21.2.1980: 31si, 9.1.1982: 22si, 19.3.1987: 32obs., 3.2.1988: 48si (Ho et al.), 8.1.1992: 35si (Uh), 12.2.1993: 69si (Fu, Pa), 28.1.1994: 62si, 25.2.1994: 99si, 26.2.1994: 101si, 5.4.1994: 60si, 8.10.1994: 42si, 23.10.1994: 21si, 27.11.1994: 90si, 14.12.1994: 101si, 30.12.1994: 99si, 14.1.1995: 118si, 21.1.1995: 110si, 12.2.1995: 103si, 25.2.1995: 94si, 12.3.1995: 75si, 29.3.1995: 73si, 9.4.1995: 74si, 13.5.1995: 8si (Fulin 1995), part Pivnica: 25.2.1995: 3si (Fu), **93. Jelšavská Teplica**, loft of church (7387), 240 m: 30.6.1992: 2 obs. (Uh), **94. Jovice**, cellar (7389), 280 m, 3.8.1977: 1ma capt. (Horáček et al. 1979), **95. Kečovo, Nad vyvieračkou c.** (7588), 400 m. 23.10.1991: 4si, **96. Kostrová c.** (7391), 700 m. 1.3.1992: 1si (Uh), **97. Krásnohorská c.** (7389), 305 m. 4.12.1993: 9si (Ta), **98. Kvaplová c.** (7489), 500 m: 4.9.1982: 2ma, 1si net (Horáček et al. 1995), winter 1991: 2si, 8.2.1992: 1si (Pa), **99. Liššia díra** (7588), 373 m: 16.10.1955: 3 capt. (Grulich & Povolný 1956), 10.12.1956: 2 ind., 5.2.1958: 6 ind., 29.5.1959: 3 ind., 19.5.1965: 13 ind., 29.6.1966: 1 ind., 13.2.1969: 3 ind. (Gaisler & Hanák 1972), 3.8.1977: 2ma, 1fa net (Horáček et al. 1979), 2.2.1980: 3si (Ho), 26.4.1989: 1si torpid, 10.6.1992: 3ma net (Horáček et al. 1995), 2.2.1988: 11si (Ho et al.), 28.11.1993: 10si, 28.5.1994: 1si torpid (Uh), 16.2.1995: 6si (Ob et al.), 18.8.1995: 2fj, 1mj net., 19.8.1995: 2mj, 1fj net. (Uh et al.), **100. Ľudmila c.** (7488), 249 m. 22–25.2.1955: 7 capt. (Grulich & Povolný 1956), 9.2.1957: 3m, 1fcapt. (Vachold 1960), Apr 1957: 2m, 3fcapt. (Štollmann & Dudich 1985), 11.12.1965: 3 ind. (Gaisler & Hanák 1972), **101. Majkova c.** (7489), 459 m. 2.6.1959: 6 ind., 18.2.1968: 5 ind. (Gaisler & Hanák 1972), 10.8.1970: 1fa net (Horáček et al. 1979), 2.2.1988: 8si (Ho et al.), 3.1.1992: 3si, 14.2.1993: 11si, 16.2.1994: 9si (Uh et al.), 17.2.1995: 19si (Ob et al.), **102. Mál c.** (7588), ca 500 m. 6.2.1958: 2 ind. (Gaisler, Hanák 1972), **103. Marciho c.** (7390), 852 m: 30.4.1990: 4 si. torpid (Horáček et al. 1995), 29.2.1992: 3si, 14.11.1992: 1si (Uh), 1.1.1994: 5si, 8.2.1995: 2si (Pa et al.), **104. Mladá c.** (7488), 420 m. 19.2.1968: 3 ind., 3.2.1970: 10 ind. (Gaisler & Hanák 1972), 20.7.1978: 1fs net, 17.9.1988: 6 si., 11.6.1992: 3ma net (Horáček et al. 1979, 1995), 2.2.1988: 24si (Ho et al.), 21.2.1992: 28si, 13.2.1993: 32si, 15.2.1994: 19si (Uh et al.), 17.2.1995: 40si (Ob et al.), **105. Moldavská c.** (7391), 216 m: 12.2.1984: 2si (Danko & Mihók 1989), 9.1.1982: 2si (Ho), 10.3.1993: 14si, 27.2.1994: 7si (Uh et al.), upper cave: 3.2.1988: 9si (Ho et al.), lower cave: 27.2.1995: 3si (Fu), **106. Nad Železnou bránou c.** (7388), ca 750 m: 4.5.1990: 1si torpid (Horáček et al. 1995), **107. Obnište c.** (7391), 600 m: 20.9.1991: 1 ind., food of *S. aluco* (Obuch 1994), **108. Ortováň c.** (7488), 478 m. 17.10.1963 (Mošanský 1980), 22.7.1978: 1ma net (Horáček et al. 1979, 1995), **109. Partizánska c.** (7488), 500 m: 25.4.1989: 1si torpid (Horáček et al. 1995), **110. Plešivec**, loft of cath. church (7488), 218 m. 4.8.1969 (Horáček et al. 1979), **111. Silica**, (7489) loft of church (456 m). 12.8.1969: 4si,

112. Silica, Kisfalú (7489), 520 m: 8.8.1970: 12si (Horáček et al. 1979), **113. Silická Ľadnica c.** (7489), 450 m: 18.2.1968 5 ind. (Gaisler & Hanák 1972), 18.9.1976: 1 ind., food of *S. aluco* (Obuch 1985a, 1994), **114. Slaninová c.** (7391), 650 m: 26.4.1987: 3–4 si (Horáček et al. 1995), **115. Slovenská skala, Veľká diera c.** (7387), 485 m: 23.1.1993: 2si (Uh), **116. Stará Domica c.** (7588), 340 m: 5.5.1954: 2m capt., 14.3.1956: 1fcapt., 16.2.1958: 1m, 1fcapt. (Vachold 1960), 30.5.1959: 3 ind., 4.3.1963: 3 ind., 18.2.1968: 10 ind. (Gaisler & Hanák 1972), 27.6.1981: 1ms torpid, 21.4.1983: 1si, 5.5.1990: 3si torpid (Horáček et al. 1995), 23.2.1979: 10si, 20.2.1980: 8si, 9.1.1982: 1si, 2.2.1988: 6si (Ho et al.), **117. Tomášova c.** (7391), 245 m: 3.3.1987: 3 capt. (Danko & Mihók 1989), 29.12.1992: 2si, 1ma, 28.12.1993: 1si, 1ma, 7.3.1993: 3si, 28.12.1993: 2si, 27.2.1994: 4si, 7.1.1995: 4si, 27.2.1995: 7si (Pa et al.), **118. Vidová, loft of church** (7488), 220 m: 15.7.1992: 2si (Uh), **119. Zádielska valley, loft of cottage** (7390), 550 m: 27.7.1978: 1si. (Horáček et al. 1979, 1995), **120. Zádielská Ľadnica c.** (7390), 850 m: 30.4.1990: 1si. obs. (Horáček et al. 1995), **121. Zbojnica c.** (7489), 380 m: 14.8.1986: 1–5 si. det., 2.5.1990: 2 torpid (Horáček et al. 1995), 26.10.1981: 1 ind., food of *S. aluco*, 16.2.1994: 1si (Ob), **122. Zvonica abyss** (7388), 670 m: 13.5.1983: 1 net., 8.6.1992: 1 net (Horáček et al. 1995)

Volovské vrchy Mts. (070)

123. Košice-Bankov, gallery (7293), 405 m: winter 1861 (Jeitteles 1862), **124. Košická Belá, Pod Širokým hrbkom** gallery (7292), 585 m: 22.9.1963 (Mošanský 1980), 31.1.1982: 2si, 13.1.1985: 2si, 1.2.1986: 2si (Danko & Mihók 1989), 28.1.1995: 1si (Da), **125. Medzev-Bodoka, loft** (7291), 350 m: 6.6.1982: 20 obs. (Danko & Mihók 1989), **126. Medzev-Čendeš cellar** (7291), 400 m: 9.9.1994: 35si torpid, loft: 12si (Pa, Na), **127. Krásna Hôrka, (7389), 500 m: 8.8.1989: 15 obs. (Horáček et al. 1979), small cave: 2.6.1959: 1 ind. (Gaisler & Hanák 1972), lofts of castle: 11.5.1983: 10 obs. (Horáček et al. 1995), 128. Nižný Medzev, Šugov valley** (7391), 350 m: 30.7.1964 (Mošanský 1980), **129. Perlová valley, Tokáreň gallery** (7191), 600 m: 27.12.1994: 2si (Pa et al.), **130. Prakovce gallery** (7191), 400 m: 26.12.1993: 1si (Pačnovský 1995), **131. Prakovce-Barbora gallery** (7191), 700 m: 4.3.1995: 3si, **132. Prakovce-Hutno, gallery** (7191), 400 m: 27.12.1994: 1si (Pa et al.), **133. Priečhodný kanál gallery** (7290), 800 m: 22.1.1994: 5si (Pačnovský 1995), 12.3.1995: 1si (Pa), **134. Pod Jahodnou gallery** (7292), ca 500 m: 16.3.1985: 1si (Danko & Mihók 1989), **135. Šarkanova diera c.** (7190), 860 m: 26.2.1995: 4si, **136. Štós, loft of gamekeeper's cottage** (7290), 400 m: 23.6.1994: 11si (Da)

Čierna Hora Mts. (080)

137. Biela skala, Povaľová c. (7192), 800 m: 26.12.1991: 1si, **138. Kavečany, Zlomová c.** (7293), 500 m: 20.2.1994: 1si (Pa, Te), **139. Košice-Čermel'ská valley, loft** (7293), 298 m: 5.7.1943, 25.7.1944, 6.8.1957 (Mošanský 1957, 1980), **140. Košická Belá, Pod Vysokým vrchom gallery** (7192), 600 m: 27.11.1983: 1 ind., 7.1.1984: 1 ind., 31.1.1985: 2 ind., 4.3.1987: 1 ind. (Danko & Mihók 1989), 4 galleries: 3.3.1964: 3 ind. (Gaisler & Hanák 1972), **141. V Kysaku c.** (7193), 354 m: 1.2.1987: 3si (Danko & Mihók 1989), 6.2.1994: 1si (Pa), **142. Ružín, Pod Sivcom c.** (7192), ca 550 m: 13.1.1985: 1 ind. (Danko & Mihók 1989), **143. Veľká Lodina, V Humenci c.** (7193), 420 m: 6.12.1958 (Mošanský 1980).

Malé Karpaty Mts. (090)

144. Buková (7470), 320 m, gallery: 9.4.1958: 1 ind., 21.1.1959: 1 ind., 30.3.1959: 1 ind. (Matoušek 1961), 13.3.1984: 1m capt., 31.10.1985: 1m capt., winters 1984–1990: 22 obs. (Mutkovič 1987, 1993), **145. Červená baňa, gallery** (7570), ca 400 m: winter 1993/94: 9si, **146. Červený Kameň, cellar** (7670), 339 m: winter 1993/94: 7si, **147. Doľany, loft of chapel** (7570), 251 m: summer 1994: 30si (Lc), **148. Driny c.** (7470), 360 m: 8.12.1954: 2m, 4fcapt., 27.7.1955: 1m capt., 1.9.1955: 10m, 6fcapt. (Vachold 1960), 11.2.1961: 4 ind. (Gaisler & Hanák 1972), 14.2.1984: 37 obs., 5m, 1fcapt., winters 1984–1990: 43 obs. (Mutkovič 1987, 1993), **149. Jablonica, cavern in a quarry** (7370), 211 m: 28.4.1958: 1 ind. (Matoušek 1961), **150. Kamzík I. military bunker** (7868), 430 m: 26.11.1994: 1si, 19.1.1995: 1si, 23.2.1995: 1si (Noga 1995), **151. Kamzík III. military bunker** (7868), 430 m: 17.11.1994: 1si (Noga 1995), **152. Klenová c.** (7470) 535 m: 16.10.1985: 1m capt., winters 1984–1990: 4 obs. (Mutkovič 1987, 1993), **153. Mariánka, loft of church** (7768), 220 m: summer 1994: 2si (Lc), **154. Medené hámre gallery** (7768), 450 m: 4.2.1995: 1si (Lehotský & Lehotská 1995), **155. Plavecká c.** (7569), 240 m: 6.4.1955: 1m, 1fcapt., 27.7.1955: 2m capt., 9.2.1956: 2m capt., 17.4.1957: 2m, 1fcapt., 3.4.1958: 1m capt. (Vachold 1960), 11.2.1961: 15 ind., 23.10.1964: 3 ind., 18.5.1965: 2 ind. (Gaisler & Hanák 1972), winters 1984–1990: 48 obs. (Mutkovič 1993), winter 1993/94: 7si (Lc), **156. Stopy c.** (7471), 428 m: winters 1984–1990: 6 obs. (Mutkovič 1993), **157. Tmavá skala c.** (7469), 500 m: 3.4.1958: 2m capt. (Vachold 1960), winters 1984–1990: 3 obs. (Mutkovič 1993), 26.2.1995: 4si (Lehotský & Lehotská 1995), **158. Trojuholník c.** (7768), ca 400 m: winter 1993/94: 2si, **159. Zbojnica c.** (7768), 400 m: winter 1993/94: 1si (Lc), **160. Zborená military bunker** (7868), 300–400 m: 26.11.1994: 1si (Noga 1995).

Tribeč Mts. (110)

161. Jelenec, (7575), 514 m, cellar: 28.9.1967: 1m, castle: 20.11.1968: 1m, 5.7.1969: 1m (Ligač 1986), 162. Zobor, Svoradova c. (7674), 100–200 m: 22.6.1969: 4 ind. (Ligač 1986), **163. Veľký vrch** (7376), 350–400 m: 15.7.1979: 1 ind., food of *B. bubo*, R (Obuch 1980, 1985a).

Stražovské vrchy Mts (120)

164. Pod Jedľovníkom c. (6877), ca 450 m 27 I 1966 3 ind (Darola & Štollmann 1974, Štollmann 1968a), **165. Pružinska c.** (6976), 590 m 10 II 1966 6 ind (Štollmann 1968a), **166. Skalky**, 3 caves (6878), 530 m 14 II 1980 2si, 30 I 1982 2si (Ob), **167. Zemianska c.** (6976), 525 m 12 II 1968 2 ind (Gaisler & Hanak 1972)

Malá Fatra Mts (140)

168. Ďurčianska c. (6978), 770 m 13 II 1968 1 ind (Gaisler & Hanak 1972), **169. Fačkov, cellar** (7077), 536 m 22 IX 1955 1m capt (Vachold 1960), **170. Stratenecská abyss** (6879), 1200 m 15 II 1978 1 ind, thanat (Obuch 1985a)

Veľká Fatra Mts (150)

171. Beznádejná c. (7079), 700 m 13 II 1969 3 ind (Darola & Obuch 1980), **172. Bystrická valley** (7180), 750–800 m 22 VII 1978 1 ind, food of *S. aluco* (Obuch 1985a, 1994), **173. Dolná Dedošová c.** (7080), 720 m 28 II 1972 6 ind, 26 VII 1974 1 ind (Darola & Obuch 1980, Obuch 1983), ind, thanat (Obuch 1985a), Dec 1980 2 ind, Nov 1981 1 ind, Dec 1982 1 ind (Obuch 1983), 27 II 1983 1si (Ob), **174. Dolná Stĺpová c.** (7079), 851 m 27 II 1983 1si, 26 II 1984 1si, 13 II 1988 2si, 20 I 1991 2si, 29 II 1993 1si, 4 II 1993 1si, 18 I 1994 1si, 26 II 1994 2si (Ob), **175. Dolná Túfna c.** (7180), 950 m 13 II 1961 2 ind (Gaisler & Hanak 1972), **176. Harmanecká c.** (7180), 826 m 12 II 1961 6 ind, 28 II 1963 10 ind, 26 II 1964 2 ind (Gaisler & Hanak 1972), 15 III 1995 3si (Ob), **177. Havranová c.** (7079), 820 m March 1974 1 ind, Dec 1980, Nov 1981 1 ind (Obuch 1983), 7 V and 9–10 VI 1976 2 ind, food of *S. aluco* (Obuch 1985a, Obuch & Darola 1980), 29 II 1993 1si, 18 I 1994 1si, 26 II 1994 3si (Ob), **178. Horná Dedošová c.** (7080), 970 m 31 X 1977 1si (Darola & Obuch 1980), **179. Horná Stĺpová c.** (7079), ca 900 m 26 II 1994 1si (Ob), **180. Javorina c.** (7080), 900 m 7 I 1990 6si, 9 III 1991 5si, 22 II 1994 9si (Ob), **181. Mažarná c.** (7079), 800 m 9 I 1960 2ma capt (Štollmann 1968a), 17 II 1971 2 ind, 25 II 1969 2 ind (Darola & Obuch 1980), 20 I 1991 1si, 29 II 1993 6si, 18 I 1994 6si, **182. Perlová c.** (7080), 860 m 9 III 1991 1si (Ob), **183. Piesočná c.** (7079), 800 m 7 III 1974 2 ind (Darola & Obuch 1980, Obuch 1983), Dec 1980 3 ind, Nov 1981 2 ind, Dec 1982 2 ind (Obuch 1983), 27 II 1983 1si, 26 II 1984 2si, 23 II 1990 2si, 20 I 1991 1si, 4 II 1993 2si, 29 II 1993 2si, 18 I 1994 2si, 26 II 1994 2si, **184. Pri tuneli c.** (7180), ca 800 m 19 II 1978 67 ind, food of *S. aluco*, 19 II 1978 5 ind, food of *S. aluco*, **185. Suchá I c.** (7080), 920 m 9 III 1991 1si, 22 II 1994 1si, **186. Suchá 2 c.** (7080), 900 m 22 II 1994 2si, **187. Žiarna 1 c.** (7080), 580 m 9 III 1991 3si, **188. Žiarna 2 c.** (7080), 600 m 28 II 1989 47 ind, thanat, 9 III 1991 2si (Ob)

Vysoké Tatry Mts (182)

189. Javorová valley, Veterná-Čiernohorská nižná c. (6787), 1488 m 4 II 1993 1si (Tc)

Belianske Tatry Mts (183)

190. Belianska c. (6787), 890 m: 11 II 1955 1m capt, 28 II 1957 1m capt, 12 II 1958 1m, 1f capt (Vachold, 1956, 1960), 25 II 1995 1si (Da, Pj)

Nízke Tatry Mts (190)

191. Barania c. (7183), 890 m winter 1954/55 3 ind (Vachold 1961), **192. Bystrianska c.** (7183), 566 m 20 I 1956 30 ind, 31 I 1956 1m, 1f capt, 18 II 1958 51m, 36f capt (Vachold 1960), 5 III 1964 3ma capt (Štollmann 1968a, b), 12 II 1969 97 ind (Gaisler & Hanak 1972), I–6 II 1988 18si (Ha et al), **193. Demanovská c.** (7083), 812 m 20–25 II 1956 (Mošanský 1980), **194. Demanovská Fádová c.** (7083), 840 m 18 I 1955 (Mošanský 1980), **195. Dračia Fádová c.** (7183), 840 m winter 1955/56 1 ind (Vachold 1961), **196. Okno c.** (7083), 915 m winter 1954/55 4m, 2f capt, winter 1955/56 5m, 1f capt, winter 1956/57 4m, 3f capt, winter 1957/58 2m, 2f capt, winter 1958/59 1m capt (Vachold 1961), 28 II 1964 2 ind (Gaisler & Hanak 1972), 12 IX 1982 1 ind, food of *S. aluco*, SF (Ob), **197. Pod Baštou c.** (7083), ca 820 m winter 1958/59 2m, 1f (Vachold 1961), **198. Pustá c.** (7083), 943 m winter 1954/55 2m, 1f, winter 1955/56 23m, 4f, winter 1956/57 3m, 8f, winter 1957/58 17m, 12f, winter 1958/59 16m, 14f (Vachold 1961), 29 I 1994 3si (Ko), **199. Sokolová c.** (6984), 1100 m 27 II 1976 1 ind, 25 VI 1977 1 net (Horáček et al 1979),

Bramsko Mts (210)

200. Zlá džura c. (6991), 900 m winter 1959 8 ind, winter 1960 12 ind, winter 1967 7 ind (Palášthy 1967)

Žilinská kotlina basin (220)

201. Rajec, cellar (6977), 455 m 21 IX 1955 1m capt (Vachold 1960)

Hornomitranská kotlina basin (230)

202. Bojnice (7277), 290 m, loft and cellars 1 IX 1954 26m, 20f capt (Vachold 1960), castle 16 VII 1979 1 ind, food of *T. alba* (Obuch 1980)

Turčianska kotlina basin (240)

203. Blatnica, (7079), 500 m, loft of evang. church: 14. and 16.7.1982: 23 obs. (Grimmberger 1983), summers 1992, 1993 and 1994 ca 40 obs. (Ob), loft of cath. church Aug. 1972 41+20 obs., July 1982. 7 ind., July 1973. 32 obs., loft of manor-house: Aug. 1972 50 obs., July 1973. 66 obs. (Obuch 1983), **204. Necpaly**, loft (7079), 510 m. 14.7.1982: 7 obs. (Grimmberger 1983).

Liptovská kotlina basin (251)

205. Lískovská c. (6982), 500 m: 6.2.1970: 10 ind. (Gaisler & Hanák 1972).

Popradská kotlina basin (252)

206. Lúbica (6888), 620 m: dat.?: 1 ind., food of *T. alba* (Schaeffer 1933).

Horechonské podolie Mts. (270)

207. Heľpa, loft of church (7185), 740 m. 15.7.1994: 1 obs. (Uh), **208. Márnikova c.** (7186), 770 m: 14.2.1968: 30 ind., 5.2.1970. 20 ind. (Gaisler & Hanák 1972), 14.12.1994: 6si (Uh), 28.2.1995 17si (Pj), **209. Valkovňa gallery** (7186), 725 m. 29.12.1994. 2si (Uh, Pa).

Štávnické vrchy Mts. (300)

210. Antol, Jurajova gallery (7579), 452 m. winter 1974 1si (Uhrin et al. 1995), 13.2.1990: 1 dead ind. (Ho), **211. Banky I.**, gallery (7579), 590 m: 8.3.1984. 3si, 7.2.1986. 2si (Uhrin et al. 1995), 13.2.1990: 1 ind. (Ho), **212. Banky II.**, gallery (7579), 600 m. 11.1.1994: 1si (Uh et al. 1995), **213. Banky-Vincent gallery** (7579), 560 m. 13.2.1990. 1 ind. (Ho), **214. Banská Štiavnica** (7579), 600 m: June 1888 (Petricskó 1892), gallery 17.9.1954. 3m capt. (Vachold 1960), **215. Bukovec gallery** (7479), 510 m. 16.12.1982, 9.3.1989. 4si, 27.1.1995 1si (Uhrin et al. 1995), 13.2.1990. 3 ind. dead (Ho), **216. Floriánka gallery** (7578), 770 m: 16.3.1984. 6si, 11.1.1994 13si, 27.1.1995 7si (Uhrin et al. 1995), **217. Hodrušské jezero gallery** (7578), 480 m: 16.3.1984, **218. Ignác gallery** (7579), 590 m. 13.3.1984. 11si, 23.3.1984 11si, 31.3.1984: 9si, 5.4.1984: 9si, 5.2.1986: 5, 21.2.1986. 6si, 11.1.1989. 12si, 10.1.1994: 10si, 26.1.1995: 17si, **219. Kírályi gallery** (7479), 500 m. 28.10.1983 (Uhrin et al. 1995), **220. Kráľovce-Krnišov** (7679), 330 m: 12.12.1954: 2m, 1f capt. (Vachold 1960), **221. Krasová jaskyňa Prvá** (7579), 720 m: 15.4.1983 2si, 19.2.1984: 5si, 3.4.1984. 2si, 26.1.1986: 2si, 9.3.1989 3si, **222. Olovená gallery** (7579), 650 m: 27.1.1995: 3si, **223. Pod Floriánkou gallery** (7579), ca 600 m. 27.1.1995: 1si, **224. Pod Kamenným jarkom gallery** (7479), 410 m: 13.2.1990: 3si, 10.1.1994 9si, 27.1.1995. 3si, **225. Rabenstein gallery** (7579), 810 m: 16.3.1984: 1si (Uhrin et al. 1995), **226. Repište gallery** (7579), 450 m: 27.1.1995 1si (Uh et al.), **227. Sklené Teplice**, (7479), 360 m, small cave (Voštinová c.) 15.9.1954: 80 obs. (Vachold 1960), 19.2.1984: 5si, 15.4.1983 2si, 3.4.1984: 2si, 3.8.1984 2si, gallery: 3.4.1984. 2si, **228. Schöpfer mine** (7579), 320 m. 21.2.1995 30si, **229. Staré Mesto gallery** (7579), 770 m: Oct. 1983. 1si, **230. Windischleuten gallery** (7579), 510 m: 8.3.1984. 3si, **231. Zlatý stôl I.** gallery (7578), 500 m. 28.10.1983, 12.2.1984 1si, 13.2.1990: 5si, 10.1.1994. 4si, 26.1.1995: 6si, **232. Zlatý stôl II.** gallery (7578), 500 m: 27.1.1995 6si (Uhrin et al. 1995).

Kremnické vrchy Mts. (310)

233. Dolná Ves, tower of church (7379), 420 m. 30.6.1955. 1m capt., **234. Ihráč**, loft of church (7379), 419 m: 30.6.1955: 4m capt., **235. Jastrabá**, loft of church (7379), 415 m: 30.6.1955. 1m capt., **236. Kremnica**, cellar (7277), 550 m. 2.7.1955: 1m capt., **237. Slaská** (7379), 426 m: 1.7.1955: 11f obs. (all Vachold 1960)

Krupinská planina Mts. (350)

238. Bzovík (7680), 420 m: 3.6.1956: 1 ind., **239. Kostolné Moravce**, cellar (7879), ca 400 m. 2.6.1955 1m capt., **240. Krupina**, cellar (7680), 262 m. 11.12.1954. 1m capt., **241. Medovarce**, cellars (7780), 400 m: 21.4.1954: 3m capt. (Vachold 1956, 1960).

Zvolenská kotlina basin (360)

242. Dúbravica, loft of church (7381), 440 m. 10.6.1993 3 obs., **243. Zvolen**, castle (7480), 293 m: 14.5.1987: 2 ind. (Uhrin 1994).

Žiarska kotlina basin (380)

244. Čabrad (7781), 300 m: 8.6.1961: 1m, 1f capt. (Štollmann 1968a), cellar 18.7.1954: 1m capt., church: 18.7.1954. 60 obs. (Vachold 1960).

Lučenská kotlina basin (392)

245. Halíž, loft of castle (7683), 274 m: 29.6.1982: colony 10 FG (Horáček et al. 1995)

Rimavská kotlina basin (393)

246. Gemerská Panica, tower of church (7588), 194 m: 27.6.1982: 1si (Horáček et al. 1995), **247. Hutníanska j. (Rozgyáry) c.** (7487), 198 m: 10.5.1995: 2 obs. (Uhrin & Benda 1995), **248. Peskô c.** (7588), 210 m: 27.6.1982 1si obs., 2si. net. (Horáček et al. 1995), 10.5.1995. 1 obs. (Uhrin & Benda 1995), **249. Peskô II. c.** (7588), 200 m: 27.6.1982: 1si (Ho), **250. Teplý vrch** (7586), 214 m: Aug. 1898 (Topál 1954), May 1981: 1 ind., food of *A. otus* (Obuch 1985d), **251. Tornaľa**

(7587), 183 m loft of child house; 27.6.1982: 8–10 obs. fG, loft of evang. church; 27.6.1982: 1 si (Horáček et al. 1995), **252. Velká v Maši c.** (7588), 200 m: 6.3.1993: 2 si (Uhrin & Benda 1995).

Košická kotlina basin (400)

253. Fintice, loft (6993), 270 m: May–Aug. 1970: 1 obs. (Palášthy 1971), **254. Kecerove**, loft (7194), 320 m: Aug. 1986 several obs. (Danko & Mihók 1989), 5.8.1987: 1 f (Da), **255. Kecerovské Pekľany**, loft (7194), 328 m: May–Aug. 1970: 10 obs., **256. Opiná**, loft (7194), 367 m: May–Aug. 1970: 46 obs., **257. Ruská Nová Ves**, loft (7093), 430 m: May–Aug. 1970: 8 obs., **258. Šarišské Bohdanovce**, loft (7193), 225 m: May–Aug. 1970: 35 obs., **259. Záborské**, loft (7093), 320 m: May–Aug. 1970: 1 obs. (Palášthy 1971), **260. Žarnov**, loft (7491), 210 m: 19.5.1960 (Mošanský 1980).

Burda Mts. (420)

261. Kováčovské kopce galleries (8178), 380 m: 15.10.1955: 3 m, 4 f capt. (Vachold 1960).

Cerová vrchovina Mts. (430)

262. Labyrintová jaskyňa c. (7885), ca 550 m: 2.6.1995: 2 obs. (Uhrin & Benda 1995), **263. Nyáryho c.** (7885), ca 550 m: 2.6.1995: 1 obs., **264. Stíčov c.** (7885), ca 500 m: 9.7.1994: 1 si (Uhrin & Benda 1995).

Slanské vrchy Mts (440)

265. Banské loft (7195), 350 m: summer 1995: 4 si, **266. Cabov** loft (7195), 210 m: summer 1995: 1 si (Pjenčák 1995), **267. Dargov**, gamekeepers cottage (7295), 320 m: 21.6.1994: 18 si (Da), **268. Dubník**, (7094), ca 650 m: 21 galleries: 28.2.1987: 2 si (Danko & Mihók 1989), gallery no. 1: 14.3.1989: 1 si, 1.2.1994: 1 si, gallery no. 2: 16.1.1990: 1 si, 19.2.1992: 1 si, gallery no. 3 (700 m): 13.2.1991: 1 si, gallery no. 4 (700 m): 10.12.1992: 1 si, 1.2.1994: 1 si, gallery no. 7 (750 m): 11.12.1992: 5 si (Da), 6.12.1993: 6 si (Pj), 1.2.1994: 6 si, gallery without mark (700 m): 13.2.1991: 2 si, 19.2.1992: 1 si, 1.2.1994: 1 si (Da), 19 galleries: Feb. 1995: 12 si (Da, Pj), **269. Kokošovce-Zlatá Baňa** loft, (7094), 400–500 m: 3.8.1988: 1 obs. (Kaňuch & Takáč 1988), **270. Leštiny**, mine (7094), 750 m: Feb. 1994: 10 si, 17.12.1994: 109 si (Da, Pj), **271. Libanka**, mine (7094), 625 m: 4.3.1987: 2 obs., March 1985: 13 obs., Feb. 1986: 82 obs., Jan.–Feb. 1987: 139 obs. (Danko & Mihók 1989), 6.1–12.3.1988: 164 si, 29.1.–12.3.1990: 205 si, 8.2.–1.3.1994: 143 si, Jan. 1995: 24 si (Da, Pj), part Apolónia: 19.2.1992: 2 si, 10.12.1992: 2 si (Da), 6.3.1993: 5 si, 6.12.1993: 12 si (Pj), **272. Malá Šimonka**, mine (7094), 880 m: 14.3.1987: 22 si, 2 fa (Danko & Mihók 1989), Jan. 1990: 12 si (Ta), upper part only: 11.12.1992: 34 si, 3.3.1994: 8 si, 12.1.1995: 46 si (Da, Pj), **273. Opiná**, loft of house (7094), 340 m: 7.9.1993: 1 obs. (Pa), **274. Slančík**, loft (7394), 300 m: July 1972: hundreds of ind., 16.5.1976: dozens obs. (Danko & Mihók 1989), **275. Zamutov** (7094), 460 m, galleries: 3.12.1992: 3 si, 27.2.1993: 4 si, 28.11.1993: 3 si, 6.12.1993: 3 si, 6.3.1994: 2 si, 20.11.1994: 2 si, 10.12.1994: 2 si, 6.1.1995: 3 si, 23.2.1995: 3 si (Pjenčák 1995), **276. Zlatá Baňa-Jozef** gallery (7094), ca 500 m: 12.1.1995: 1 si (Pj), **277. Slanská Huta**, military bunker (7494), 525 m: 17. a 20.7.1964: colony of fa and j (Mošanský 1980), **278. Žehňa**, loft (7094), 426 m, 3.8.1988: 16 obs.: 1 f (Kaňuch & Takáč 1988).

Považské podolie Mts (490)

279. Trenčín (7174), 211 m: June 1898 (Vachold 1960)

Oravská vrchovina Mts (590)

280. Oravský Podzámok, castle (6782), 613 m: June ? (Kocyan 1887)

Pieniny Mts (600)

281. Aksamitka c. (6688), 756 m: 11.11.1955: 10 ind. (Vachold 1960), 2.3.1963: 3 ind. (Gaister & Hanák 1972), 26.7.1972: 4 m net. (Horáček et al. 1979), 15.7.1975: 14 f, j net. (Štollmann & Randík 1979), 23.–24.7.1975: 9 ma, 1 fs net, 30–31.7.1975: 1 m net (Bárta 1978), 17.2.1994: 152 si, 18.6.1994: 42 torpid, 3.12.1994: 158 si, 27.2.1995: 145 si (Da, Pj), **282. Červený Kláštor** (6688), 465 m: 15.7.1975: 80 f (Bárta 1978, Štollmann & Randík 1979), ground-floor room of monastery: 12.7.1994: 15 obs., loft of monastery: 12.7.1994: 33 obs., loft of restaurant: 12.7.1994: 62 obs. (Da, Uh), **283. Lesnica**, loft of church (6688), 485 m: 15.7.1975: 14 f, juv. (Bárta 1978), 12.7.1994: 21 obs. (Da, Uh), **284. Stráňany**, loft (6689), 650 m: 15.7.1975: 5 f, 3 j (Bárta 1978), **285. Veľký Lipták**, loft of church (6689), 580 m: 15.7.1975: 1 m (Bárta 1978), 12.7.1994: 4 obs. (Da, Uh)

Čergov Mts. (620)

286. Červená voda, loft (6892), 500 m: May–Aug. 1970: 43 obs., **287. Hradisko**, loft (6893), 757 m: May–Aug. 1970: 6 obs., **288. Milpoš**, loft (6892), 500 m: May–Aug. 1970: 31 obs. (Palášthy 1971)

Spišská Magura Mts (660)

289. Haligovce, loft of church tower (6688), 600 m: 12.7.1994: 2 obs. (Da, Uh).

Levočské vrchy Mts. (670)

290. Brezovica, loft (6891), 455 m: May–Aug. 1970: 36 obs., **291. Kamenica**, loft (6891), 490 m: May–Aug. 1970: 11 obs., **292. Tichý Potok**, loft (6890), 520 m: May–Aug. 1970: 72 obs. (Palášthy 1971), 14.10.1990: 2 obs: 1 net. (Fu, Pa).

Spišskošanšské medzihorie Mts. (690)

293. Stará Ľubovňa, loft of church (6990), 545 m: summer 1974: 100 obs. (Štollmann & Randík 1979).

Šarišská vrchovina Mts (700)

294. Bajerovce, loft (6790), 345 m: May–Aug. 1970: 26 obs., **295. Bzenov**, loft (7093), 300 m: May–Aug. 1970: 1 obs., **296. Dačov**, loft (6891), 420 m: May–Aug. 1970: 10 obs., **297. Hendrichovce**, loft (6991), 420 m: May–Aug. 1970: 36 obs., **298. Hermanovce**, loft (6992), 460 m: May–Aug. 1970: 18 obs., **299. Janov**, loft (7093), 305 m: May–Aug. 1970: 2 obs., **300. Klenov**, loft (7092), 540 m: May–Aug. 1970: 35 obs. (Palášthy 1971), **301. Lipovce**, loft (6991), 585 m: summer 1959: 60 obs. (Palášthy 1967), Aug. 1970: 70–80 obs. (Danko & Mihók 1989), **302. Mošurov**, loft (6893), 365 m: May–Aug. 1970: 2 obs., **303. Nižný Slavkov**, loft (6891), 510 m: May–Aug. 1970: 37 obs., **304. Ražňany**, loft (6992), 350 m: May–Aug. 1970: 16 obs., **305. Renčiov**, loft (6992), 615 m: May–Aug. 1970: 106 obs., **306. Rokycany**, loft (7092), 315 m: May–Aug. 1970: 45 obs., **307. Rožkovany**, loft (6891), 370 m: May–Aug. 1970: 6 obs., **308. Ruské Pekľany**, loft (7093), 310 m: May–Aug. 1970: 12 obs., **309. Široké**, loft (7091), 510 m: May–Aug. 1970: 3 obs., **310. Torysa**, loft (6891), 420 m: May–Aug. 1970: 16 obs., **311. Uzovský Šalgov**, loft (6992), 375 m: May–Aug. 1970, **312. Žipov**, loft (7092), 300–400 m: May–Aug. 1970: 42 obs. (Palášthy 1971).

Vihorlat Mts. (710)

313. Jasenov, gallery (7198), 360 m: 1.11.1973: 2 ind. (Danko & Bencš 1976, Danko & Mihók 1989), 10.1.1978: 1 ind. (Danko & Mihók 1989), 13.4.1988: 1 si, 24.1.1989: 1 capt., 8.2.1989: 1 si (Th), 22.2.1989: 1 si (Da), 27.10.1993: 1 si (Th), 30.1.1994: 1 si (Da), **314. Podhorod'**, loft of church (7199), 340 m: 17.6.1976: 20 obs. (Anděra et al. 1982, Horáček et al. 1979), 31.7.1994: min. 73 obs. (Da), **315. Remetské Hámre**, loft (7199), 300 m: 3.7.1984: 1 obs. (Danko & Mihók 1989), **316. Strážske-Krivošťany**, gallery (7197) 250 m: Dec. 1982: 1 ind., Nov. 1983: 1 ind., Dec. 1984: 1 obs. (Danko & Mihók 1989).

Ondavská vrchovina Mts (740)

317. Detrik, loft of church (6995), 340 m: 30.7.1987: 12 obs., summer 1995: 9 si, **318. Ďurďoš** loft (6995), 200 m: summer 1995: 25 si (Pjenčák 1995), **319. Geraltov**, loft (6893), 505 m: May–Aug. 1970: 1 obs. (Palášthy 1971), **320. Matiaška**, church (6995), 240 m: 8.6.1994: 13 si (Pj), summer 1995: 9 si (Pjenčák 1995).

Beskydské predhorie Mts (760)

321. Beňatina, loft of church (7199), 400 m: 3.8.1994: 10 obs. (Da), **322. Petkovce** loft (6995), 230 m: summer 1995: 31 si (Pjenčák 1995), **323. Ruský Hrabovec**, tower of church (7100), 280 m: 3.8.1994: 40 obs., 17.6.1995: colony (Danko 1995), **324. Skrabské** loft (6995), 160 m: summer 1995: 7 si, **325. Vavrinec**, church (6995), 300 m: 10.8.1994: 30 obs., summer 1995: 15 si (Pjenčák 1995), **326. Vyšná Hurka I. c.** (7100), 400 m: 15.4.1973: 1 ind. (Hochmuth & Zanvit 1976), 22.10.1994: 2 si, 4.2.1995: 1 si (Da), **327. Vyšný Žipov**, cellar (7095), 155 m: 21.4.1994: 14 si, 15.11.1994: 1 si (Pj).

Borská nížina lowland (770)

328. Veľké Leváre loft (7468), ca 120 m, summer 1995: 3 si (Kürthy et al. 1995).

Podunajská rovina lowland (790)

329. Bodíky, loft (8070), 118 m: 17.8.1963: 34 ind. (Dudich 1964).

Nitrianska pahorkatina Mts. (802)

330. Pod Hradom c. (7576), 190 m: 21.6.1969: 2 f, **331. Oponice** (7574), 168 m: 29.6.1969: 2 ind., **332. Podhorany**, (7574), 100–200 m: 20.7.1969: 1 ind., **333. Topoľčianky**, loft of castle (7576), 220 m: 25.10.1967: 2 ind. (Ligaš 1986), **334. Uhrovec** (7276), 250 m: March 1899 (Vachold 1956).

Hronská pahorkatina Mts. (804)

335. Nána cellar (8178), 110 m: 15.9.1955: 2m capt. (Vachold 1960).

Ipeľská pahorkatina Mts (805)

336. Ladzany, cellar (7779), 210 m: 19.9.1954: 1m capt. (Vachold 1960), 8.9.1987: 1 si (Uhrin et al. 1995).

Východoslovenská pahorkatina Mts. (810)

337. Jovsa, loft (7198), 140 m: 8.8.1973: 3 obs. (Danko, Mihók 1989), **338. Koromľa**, old mill (7299), 290 m: 1.8.1994: 20–30 obs. (Da), **339. Sedliská** loft of church (7096), 160 m: summer 1995: 1 si (Pjenčák 1995), **340. Stankovce**, loft of church (7295), 140 m: 2.6.1993: 1 si (Pj, Ka), **341. Zamutov, Pod Baranom** gallery (7094), 380 m: 27.3.1993: 7 si, 6.12.1993: 27 si, 9.2.1994: 13 si, 19.4.1994: 49 si, 1.9.1994: 21 si, 29.9.1994: 47 si, 5.10.1994: 66 si, 8.10.1994: 61 si, 16.10.1994: 68 si, 23.10.1994: 72 si, 6.11.1994: 62 si, 10.12.1994: 15 si, 6.1.1995: 10 si (Pjenčák 1995).

Východoslovenská rovina lowland (820)

342. Brehov, small cellar (7596), 140 m: 20.2.1988: 1 ind. (Da), **343. Malý Horeš**, cellar (7697), 100 m: 10.10.1955: 1m capt. (Vachold 1960), **344. Streda n. Bodrogom** cellar, (7696), 100 m: 11.10.1955: 3m capt. (Vachold 1960), 26.5.1980: 2 ind. (Horáček & Červený 1984).

Without complete data, unclear and invalid findings:

Muránska planina Mts.: **Muráň**, source of water-supply (7286), ca 400 m: dat ? (Vachold 1956), Malé Karpaty Mts.: **Buková**, gamekeeper's cottage (7470), 320 m: 1958–1960 (Matoušek & Matoušek 1962), Rožňavská kotlina basin: **Rožňava** (7389), 318 m: dat ? (Topál 1954), Slovenský kras Mts.: **Erňa c.** (7391), 500 m: dat ? (Vachold 1957), **Marciho c.** (7390), 852 m: dat ? (Vachold 1957), **Moldava** (7391), 220 m: dat ? (Vachold 1956), Malé Karpaty Mts.: **Driny c.** (7470), 360 m: dat ? (Vachold 1956), **Pajštún** (7768), 486 m: dat ? (Ferianc 1949), Trábeň Mts.: **Zobor, Svoradova c.** (7674), 100–200 m: 1974: several ind. (Krištín 1986), Strážovské vrchy Mts.: **Šarkanica c.** (6877), 590 m: winter ? (Darola, Štollmann 1974), Veľká Fatra Mts.: **Dolná Tŕňa** (7180), 950 m: dat ? (Ferianc 1949), **Netopieria c.** (6981), 500–600 m: dat ? (Hochmuth 1976), **Závalová na Meškove c.** (6981), 900 m: summer ? (Hochmuth 1974), Belianske Tatry Mts.: **Belianska c.** (6787), dat ? (Vachold 1956), Nízke Tatry Mts.: **Bystrianska c.** (7183), 566 m: dat ? (Ferianc 1949), Hornotranska kotlina basin: **Bojnice** (7277), 290 m: dat ? (Vachold 1956), Štiavnické vrchy Mts.: **Banská Štiavnica** (7579), 600 m: dat ? (Vachold 1960), Žiarska kotlina basin: **Čabrad** (7781), 300 m: dat ? (Ferianc 1949), Kremnické vrchy Mts.: **Bartošova Lehôtka** (7379), 390 m: winter ? (Vachold 1956), **Kosorin** (7376), 370 m: winter ? (Vachold 1956), **Stará Kramníčka** (7479), 291 m: winter ? (Vachold 1956), Spišsko-šarišské medzihorie Mts.: **Ruská Voľa**, loft (6791), 515 m: dat ? (Štollmann & Randík 1979).

Distribution

R. hipposideros is a common species, widely occurring in Slovakia (Fig. 2). It has been recorded in 344 localities (115 mapping squares, appr. 27.2% of territory) in 52 geomorphological units of Slovakia. Its occurrence is reported also in the oldest papers dealing with Slovak fauna (e. g. Jetteles 1862, Petricský 1892, Topál 1954, Kocyan 1887, Méhely 1900, Staněk 1932). It seems, that in *R. hipposideros*, an affinity to karst areas is the lowest from all three horseshoe species occurring in Slovakia. Only 194 (56.4%) of all localities lie in this type of landscape. Most of localities are in submountain and mountain karst regions and/or neighbouring large karst landscapes (viz., Muránska planina Mts. – 34 localities, Revúcka vrchovina Mts. – 29, Slovenský kras Mts. – 45, Malé Karpaty Mts. – 17, Veľká Fatra Mts. – 18) and in the mountain regions rich in old mines and galleries (Štiavnické vrchy Mts. – 23 localities, Slanské vrchy Mts. – 18). From these regions, both nursery colonies and winter records are available. Another group of localities comes from the regions in which the winter records are missing due to lack of appropriate sites and the species was recorded exclusively during summer period in loft spaces. Namely, it concerns of several lower mountains or basins (e. g. Revúcka vrchovina Mts., Košická kotlina basin, Slanské vrchy Mts., Pieniny Mts., Šarišská vrchovina Mts.). The records from lowland regions are extremely rare (Borská nížina lowland – 1 nursery colony, Východoslovenská nížina lowland – 3 findings in cellars from winter or transient period, Podunajská nížina lowland – 1 nursery colony) which can be explained with a lack of suitable hibernacula, i. e. the factor which is supposed to be of a considerable significance. Nevertheless, in just similar lowland regions of southern Moravia, this species belongs to the most numerous bats (Gaisler et al. 1988, 1990). Surprisingly, it is absent in the mountains of the external range of the Carpathian system (e. g. Biele Karpaty Mts., Javorníky Mts., Ondavská vrchovina Mts. and Laborecká vrchovina Mts., Bukovské vrchy Mts.).

Altitudinal range of all localities in Slovakia is 100–1488 m a. s. l. (Fig. 4) and most of them (66.2%) lie in 200–600 m range. The species was also recorded even above the tree line in the winter period in the Veterná-Čiernohorská cave of the High Tatra Mts. (1488 m) which is the highest point of occurrence of this species in Slovakia. The highest summer record comes from 1200 m in Muránska planina Mts., where one active individual was observed in a small cave Nad Kamenným morom.

R. hipposideros was found in the cave thanatocenoses (11 localities of the Holocene age) and in owl pellets (11 localities, mostly of the Recent age, from *Strix aluco*, *Bubo bubo* and *Tyto alba*) (e. g. Horáček 1976, Obuch 1985a, c, d, 1989, 1994, 1995b, Obuch & Uhrin 1995). In the cave thanatocenoses it amounts to 6.3% (Obuch 1995b) on average. A high percentage in the sample from Netopierov cave in Muránska planina Mts. (94.9%) corresponds to numerous col-

onies found in this cave in 60s (Vachold 1955, Gaisler & Hanák 1972). In owl pellets this species is quite a rare (*S. aluco* – 0.04% of all mammals, *T. alba* – 0.2%, *B. bubo* – 0.005%).

Tab. 1. Review of recaptured individuals of *R. hipposideros* banded in Libanka mine (No. of individuals banded / percentage of recaptured individuals)

Years	No. of <i>R. hipposideros</i> banded	Recaptured bats			
		1987	1988	1990	1994
1986	79	58/35.4	18/22.8	8/10.1	5/6.3
1987	104		32/30.8	15/14.4	6/5.8
1988	106			18/17.0	6/5.7
total	289		27.3	14.1	5.9

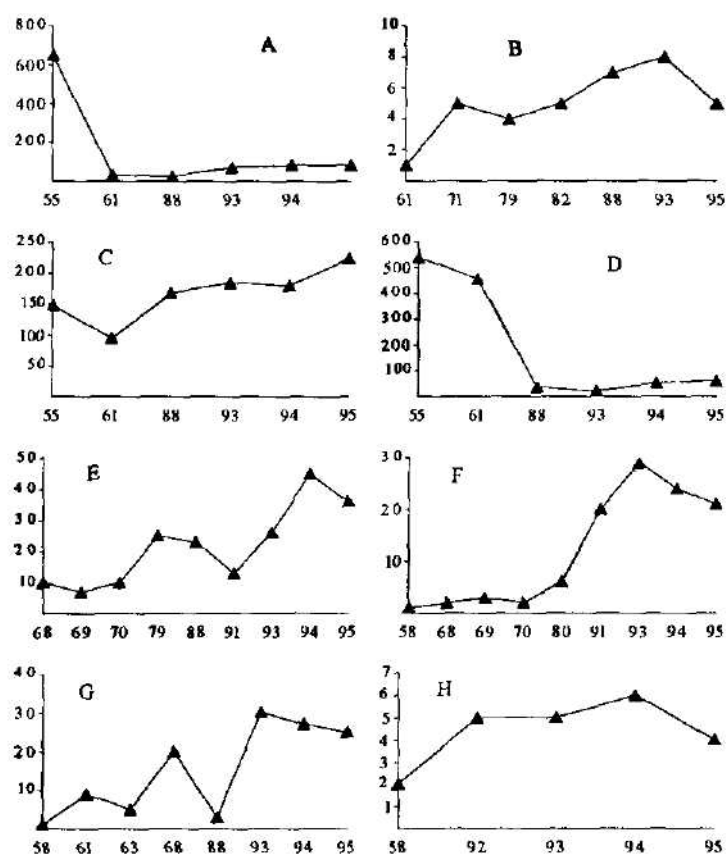


Fig. 6. Changes in abundance of *Rhinolophus hipposideros* in some hibernacula: A – Kostolík cave, B – Ladzianského cave, C – Michňová cave, D – Netopierov cave, E – Aršovská cave, F – Čertova díra cave, G – Drienovecká cave, H – Hačavská cave, I – Jasovská cave, J – Liščia díra cave, K – Majkova cave, L – Mlada cave, M – Libanka cave

Ecological notes and changes in numbers

Out of hibernacula ($n=172$), 108 (62.8%) are natural caves, 54 (31.4%) are galleries and old mines, 5 (2.9%) are cellars, 3 (1.7%) are military bunkers and 3 (1.7%) are unspecified winter findings. An average number of individuals in a winter roost per one check is 22.1 ind. (110–650, $n=475$ checks). The most populated hibernacula were Kostolík (February 1955 – 650–700 ind.) and Netopierov caves (winter 1954/1955 – 540 ind.) in Muránska planina Mts. In Netopierov cave, an average abundance in 1993–1995 period was only 8.9% of the abundances in 1955 and 1961 years (Fig. 6A, D) (Uhrin 1995). At the present time, the highest abundances were found in Michňová abyss (max. 223 ind.) and Libanka mine (max. 241 ind.).

The summer roosts of *R. hipposideros* are of a greatly diversified type in Slovakia. Most of them can be characterized as loft spaces (122 localities, 57.0%), including lofts of gamekeepers cottages and other forest buildings (4.7% of all summer shelters), lofts of churches (including towers 21.0%) and lofts of castles, monasteries, and similar houses (7.9%). Also caves are often used during the summer period, 55 records (25.7%) of solitary individuals in such a type roosts are available. This corresponds to previous data (Gaisler 1963) but, in contrast, nursery colonies were not found in caves during the recent period. The other types of summer roosts include the pseudokarst caves (3 localities, 1.4 %), cellars (16, 7.4%), roosts of nursery colonies in ground-floor rooms of buildings (2, 0.9%), galleries (3, 1.4%), a military bunker (1 locality, 0.5%) and unspecified summer findings (12, 5.6%). It seems that in the recent period almost all the population of *R. hipposideros* lives synanthropically during the summer period. The abundance recorded in loft spaces varies from 1 to 106 individuals (average is 19.0 per one check, $n=130$ checks). The largest nursery colony was found in Slančík village, where in July 1972 the colony

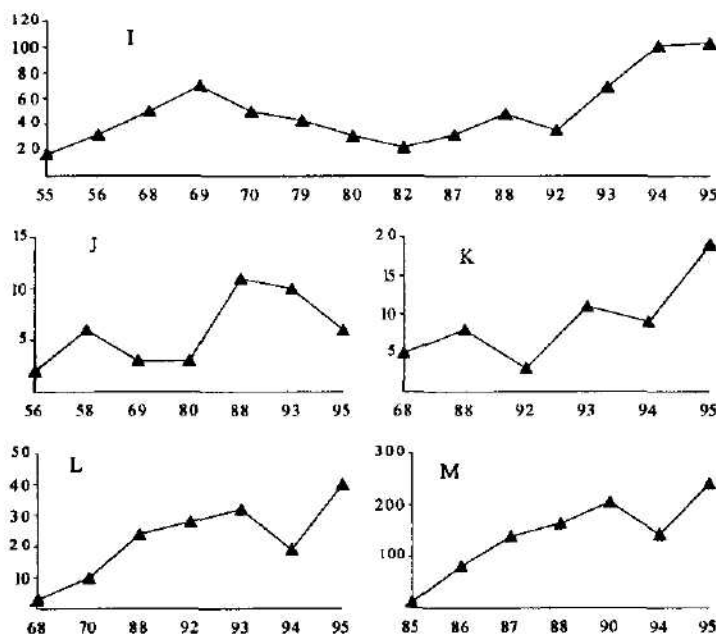


Fig. 6. (continued)

of hundreds of individuals was observed (Danko & Mihók 1989). Roosts in ground-floor rooms of buildings are worth of mentioning (Pieňny Mts Červený Kláštor, 12 July 1994 – 15 ind., Volovské vrchy Mts Medzev-Čendeš, 9 Sept 1994 – 12 ind., Revúca 11 Sept 1995 – 1 ind.). These shelters may correspond to warmer caves. From 152 netted individuals, sex of 133 was determined: 94 were males (70.7%), 39 females (29.3%). The structure of these samples was as follows: 57 ma, 13 ms, 14 mj, 10 m, 13 fa, 7 ms, 5 fj, 14 f.

The long-term changes of abundance in this species in 13 hibernacula controlled over a longer period are shown in Fig. 6. Except for caves Kostolík and Netopierov, where the drastic decline at the beginning of 60s was caused probably by human impact (banding), the abundance of this species seems to be stabilized or increasing at least in the last study period (1980–1995). Similar results were published also in Moravia (e.g. Řehák et al. 1994, Bauerová et al. 1989, Gaisler 1991, Zima et al. 1994), though the decrease may continue in other regions even in eighties (Červený & Burger 1990) similarly as in west Europe earlier (e.g. Roer 1981, Schober & Wilhelm 1984).

Banding results in *R. hipposideros* in Slovakia were published by several authors (Hanák et al. 1962, Gaisler & Hanák 1969, Danko & Mihók 1989, Palášthy 1987). Here we present other unpublished data. In 1978–1994 we banded 357 individuals of *R. hipposideros*. We found movements between hibernacula and summer roosts, between hibernacula and a repeated recovery in one hibernation place.

N 321	banded 28.2.1987 checked 21.4.1994	– Dubník, gallery no. 5, male (Da) – Vyšný Žipov, castle, 7 years 2 months, 12 km NE (Pj)
N 381	banded 28.2.1987 checked 12.3.1988 and 11.12.1992	– Dubník, gallery no. 7, male (Da) – Dubník, Libanka mine (Da)
N 432	banded 14.3.1987 checked 12.3.1988	– Dubník, gallery no. 7, 4 years, 10 months (Da) – Malá Šimonka mine, female (Da)
N 956	banded f 12.3.1988 checked 8.11.1992	– Libanka mine (Da) – Libanka mine, female (Da)
N 207232	banded f 22.2.1986 checked summer 1986 and 05.08.1987	– Zamutov, Predný laz (Pj) – Libanka mine (Da)
N 20739	banded 6.2.1986 checked 7.9.1993	– Keccerovec, 10 km SSW (Sy) – Libanka mine (Da)
N 207266	banded 22.2.1986 checked 21.4.1994	– Opina, loft of house, 6 km SSW (Sy) – Libanka mine, female (Da)
N 226289	banded 24.1.1987 checked 5.8.1987	– Vyšný Žipov, castle (Pj) – Libanka mine, female (Da)
N 226454	banded m 31.1.1987 checked 6.12.1993	– Keccerovec, loft of house (Sy) – Libanka mine, male (Da)
N 226464	banded 31.1.1987 checked 12.3.1988 and 19.4.1994	– Zamutov, Predný laz (Pj) – Libanka mine, female (Da) – ibidem (Da)
N 234280	banded 14.3.1987 checked 7.6.1988	– Zamutov, gallery no. 4 (Pj) – Malá Šimonka mine, female (Ta)
N 226314	banded m 2.1.1987 checked 1.3.1994	– Skaroš, loft of gamekeepers cottage, 38 km S (Da) – Libanka mine, male (Da)
M 952424	banded 9.3.1985 checked 1986, 1987, 1988 and 22.2.1994	– ibidem (Da) – Libanka mine, male (Da)
N 207263	banded 22.2.1986 checked 24.2.1994	– ibidem (Da) – Libanka mine, male (Da)
N 207491	banded 2.2.1986 checked in years 1988, 1990, 1991 and 1.2.1994	– Leštiny, mine (Da) – Libanka mine, female (Da) – gallery no. 3 (Da) – Libanka, gallery C (Da)

N 236461

banded 3.3.1987
checked 29.12.1992

– Tomášova cave (Pa)
– ibidem (Pa)

Review of repeat returns of this species in Libanka mine is in Tab. 1. The portion of recaptured bats was 14.4% after 3 years, 10.1% after 4 years, 5.7% after 6 years, 5.8% after 7 years and 6.3% after 8 years.

Rhinolophus euryale Blasius, 1853

Survey of the records

Muránska planina Mts. (021)

1. **Kostolík c.** (7385), 479 m: 3.2.1955: 40 obs. (Vachold 1956, 1960), 15.2.1961: 2 ind. (Hanák & Anděra 1980), 30.7.1970: 1ma (Hanák & Anděra 1980, Horáček et al. 1979).

Revúcka vrchovina Mts. (040)

2. **Burda c.** (7486), 380 m: Nov. 1970 (Gulička 1975), 3. **Chvalovská c.** (7486), 250 m: 10.7.1981: 12 obs. (Horáček et al. 1995), 30.5.1995: colony 80 obs., 4. **Podbanište c.** (7486), 352 m: 31.5.1995: 5ms, 3ma, 1fs net. (Uhrin & Benda 1995, Uhrin et al. 1996), 5. **Veľká Drienčanská c.** (7586), 280 m: 23.2.1979: 1si (Ho), 6.8.1980: 1si. obs., 25 net.: 5ma, 2ms, 6fa, 6mj, 4fj, 2si, 7.8.1980: 2ma, 5fa net. (Horáček & Červený 1984), 8.8.1980: 10 net.: 1ma, 2ms, 4fa, 2fs, 1si, 7.7.1981: 1m, 2fnet., several obs., 14.5.1983: 5m, 3fnet. (Horáček et al. 1995), 1.6.1995: 20–25 obs., 5.6.1995: 3faG net. (Uhrin & Benda 1995, Uhrin et al. 1996), 2.6.1995 and 12.6.1995: 23 ind., thanat. (Obuch 1995b), 11.9.1995: 100–200 obs.: 2mj, 1ms net. (Uhrin & Benda 1995, Uhrin et al. 1996).

Slovenský kras Mts. (060)

6. **Ardoňská c.** (7488), 314 m: 14.10.1954: 150–180 obs. (Vachold 1956, 1960), 14.9.1955: 4m, 8f capt., 18.3.1956: 2m, 2f capt., 28.6.1956: 60–80 obs., 8.2.1957: 2m, 16.2.1958: 1m (Vachold 1960), 9.12.1956: 28 ind., 4.3.1963: 300 obs.: 9

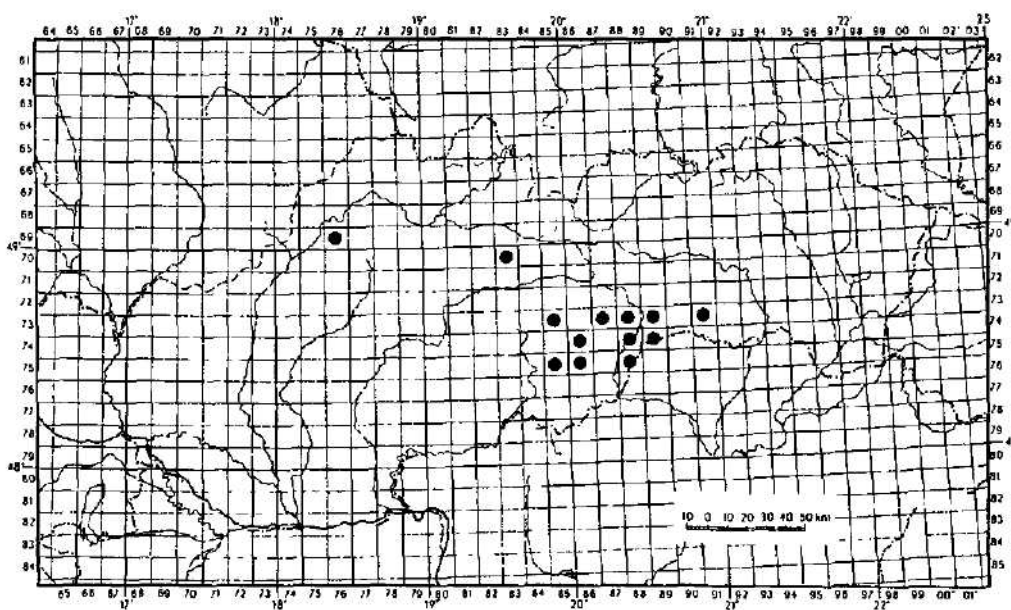


Fig. 3A. Distributional patterns of *Rhinolophus euryale* in Slovakia. For explanations see Fig. 1A.

capt., 20.5.1965: 10 ind., 19.2.1968: 165 ind., 13.2.1969: 6 ind. (Gaisler & Hanák 1972), 15.8.1970: 1ms net. (Horáček et al. 1979), 20.2.1980: 15–20 obs., 2.2.1988: 10si (Ho et al.), 14.11.1991: 5si (Uhrin 1994), 20.1.1993: 6si, 16.2.1995: 14si (Uh), 7. Čertova diera c. (7588), 370 m: 19.5.1965: 5 ind. (Gaisler & Hanák 1972), 12.8.1970: 42m, 1fs net. (Horáček et al. 1979), 20.2.1980: 20si (Ho), 17.9.1988: 3 obs., 11.6.1992: 10ma net. (Horáček et al. 1995), 17.8.1995: 12mj, 1fj, 1m net., 19.8.1995: 1ma, 10mj, 1fj, 1si net. (Uh et al.), 6.10.1993: 6ma, 16mj, 2ms, 9fa, 6fj, 2fs net. (Zu et al.), 25.4.1994: 15ma, 2ms, 13fa, 1fs net. (Uh), 16.2.1995: 1si (Uh et al.), 8. Domica c. (7588), 339 m: 21.4.1983: 2 obs., 11.6.1992: 5si obs. (Horáček et al. 1995), 21.4.1983: 2 obs., 8.2.1988: 8si (Ho), 23.10.1991: 1000si, 30.10.1991: 800si, 10.12.1991: 400si, 26.2.1992: 70si (Uhrin 1994), 3.12.1992: 300si, 16.10.1993: 182si, 19.11.1993: 1362si, 28.11.1993: 35si, 22.12.1993: 30si, 15.2.1994: 815si (Uh et al.), 16.2.1995: 90 ind. thanat. (Obuch 1995b), 16.2.1995: 1632si (Uh et al.), 9. Drienovská

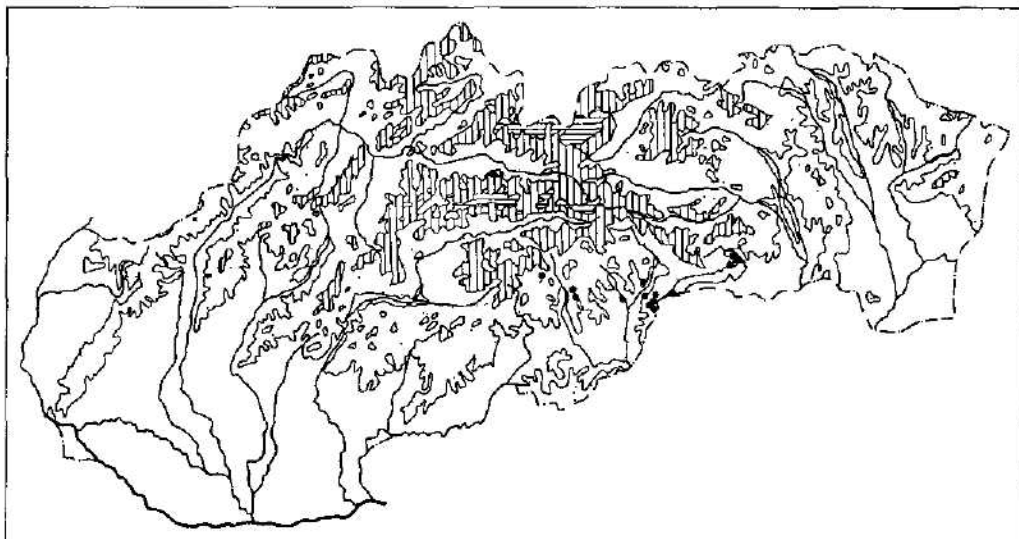
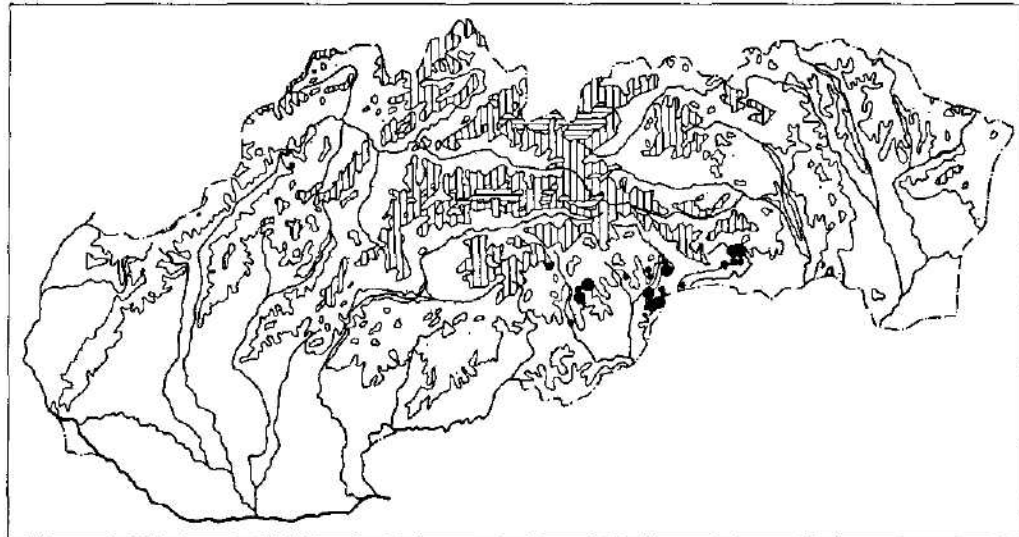


Fig. 3B. Distributional patterns of *Rhinolophus euryale* in Slovakia. For explanations see Fig. 1B.

c. (7391), 245 m winter 1954/55 8 ind (Vachold 1956), 22 4 1955 8m, 3f capt (Vachold 1956, 1960), 26 6 1956 4m capt, 8 2 1957 1m capt, 14 2 1958 2m, 1f capt (Vachold 1960), 6 2 1958 10 ind, 1 6 1959 50 ind, 17 2 1961 30 ind (Gaisler & Hanák 1962, 1972), 22 5 1965 51 ind (Gaisler & Hanák 1972), 25 4 1987 20s1 det (Horáček et al 1995), 3 2 1988 103s1 (Ho et al.), 10. *Erňa c.* (7391), 500 m 22 9 1995 1mj net (Uh, Rei), 11. *Gemerskoteplická c.* (7387), 250 m 19 9 1993 1fa, 1s1 net (Uh), 12. *Jasov* (7391), 256 m, lofts of monastery 13 6 1992 colony 60 obs (Horáček et al 1995), 13. *Jasov-Teplica* (7391), 280 m 18 4 1982 1 ind, food of *S. aluco* (Obuch 1985c, 1992), 14. *Jasovská c.* (7391), 256 m winter 1954/55 1 ind (Vachold 1956), 19 4 1955 1 ind, 20 8 1955 1 ind, 3 3 1964 1 ind, 14 2 1969 2 ind (Gaisler & Hanák 1972), 5 2 1957 3 ind, 14 2 1958 1 ind (Vachold 1957), 4 8 1970 100–150 obs 1fa, 2 8 1972 10 obs (Horáček et al 1979), 1 8 1980 4 obs (Horáček & Červený 1984), 3 8 1982 colony 6s1, 10 8 1980 3–4 s1 obs, 12 6 1992 4ma, 3fa net, 13 6 1992 8s1 obs (Horáček et al 1995), 27 11 1994 3s1, 14 12 1994 1s1, 29 1 1995 25s1, 12 2 1995 2s1, 25 2 1995 5s1, 12 3 1995 14s1 (Fulin 1995), 15. *Líščia diera c.* (7588), 373 m 17 10 1963 (Vachold 1955), 29 6 1966 300 obs 2 capt (Gaisler & Hanák 1972), 14–16 8 1969 300 obs, 13 8 1970 300 obs, 13 8 1970 27m, 1fa net, 13 6 1975 50–100 obs, 3 8 1977 60–100 obs (Horáček et al 1979), 28 6 1981 colony 250–300 obs (Horáček & Červený 1984), 27 6 1981 1ma net, 21 4 1983 3s1 obs, 10 6 1992 6ma net (Horáček et al 1995), 19 8 1992 300 obs, 6 10 1993 10ma, 4ms, 3fa, 1fs net, 20 5 1994 160 obs, 28 5 1994 5–8 obs, 50 det, 17 8 1995 8mj, 3ma net, 18 8 1995 3mj, 2 ma net, 19 8 1995 1ma net (Uh et al.), 21 9 1995 1 torpid, 3s1 obs (Rei), 16. *Krásnohorská Dlhá Lúka* (7389), 315 m, loft of school 14 8 1974 1fa, 2fs, 1fj capt, 15 8 1974 6fa, 2fs, 2mj, 1fj capt (Horáček et al 1979), loft of church tower 29 5 1980 colony 10–25 1fg, 28 6 1981 colony 50 2FG (Horáček & Červený 1984), 27 6 1982 colony 50–100 obs, 3 5 1983 2s1 (Horáček et al 1995), 17. *Ludmila c.* [Just.] (7488), 249 m 10 4 1955 (Grulich & Povolný 1955), 9 2 1957 2 capt (Vachold 1960), 18. *Milada c.* (7488), 420 m 2 2 1988 9s1 (Ho et al.), 17 9 1988 3 obs, 11 6 1992 1ma net (Horáček et al 1995), 30 5 1995 1ma, 1fa net (Uhrin & Benda 1995), 19. *Moldavská c.* (7391), 216 m 1 8 1980 1ms net (Horáček & Červený 1984), 26 4 1987 1–2 obs/det (Ho), 20. *Silická Jablonica* (7489), 256 m, loft of evang church 22 6 1978 1ma (Horáček et al 1979), loft of barracks 14 8 1986 2–5 s1 obs (Horáček et al 1995), 21. *Silická Ladnica c.* (7489), 450 m 30 4 1954 1m, 1f capt (Vachold 1960), 22. *Slaninová c.* (7391), 500 m 26 4 1987 2s1 obs (Horáček et al 1995), 23. *Stará Domica c.* (7588), 340 m 30 5 1959 16 ind, 20 5 1965 5+40 ind (Gaisler & Hanák 1972), 15 8 1969 10 obs (Horáček et al 1979), 24. *Zvonica abyss* (7388), 500 m 13 5 1983 1s1 net (Horáček et al 1995), 25. *Zbojnická c.* (7489), 380 m 26 10 1981 2 ind, food of *S. aluco* (Ob)

Volovské vrchy Mts (070)

26. *Krásna Hôrka*, cellar (7389), 500 m 8 9 1969 30 skeletons (Horáček et al 1979, Horáček & Zima 1979)

Strážovské vrchy Mts (120)

27. *Pružinská c.* (6976), 590 m 9 7 1960 1 ind (Zajonc 1963)

Nízke Tatry Mts (190)

28. *Pustá c.* (7083), 943 m dat ?, 1 ind thanat (Rybař 1980)

Rimavská kotlina basin (393)

29. *Malé Teriachovce* (7585), 248 m, loft of evang church 8 5 1981 2s1 obs (Horáček & Červený 1984, Horáček et al 1995), 30. *Veľká v Maši c.* (7588), 200 m 6 3 1993 1capt (Uhrin 1993a)

Without complete data, unclear and unvalid findings

Slovenský kras Mts : *Domica c.* (7588), 339 m before 1938 (Štěpánek 1938), 1949 (Vachold 1956), 1952 (Grulich & Povolný 1955), *Plešivec* (7488), 218 m dat ? (Topál 1954), Nízke Tatry Mts : *Demanovská c.* (7083), 812 m 21 3 1938 8 ind (Gaisler 1956), Podunajská rovina lowland *Jurský Šúr* (7769), ca 200 m, pit of sewerage dat ? (Vachold 1960), *Šamorín* (7969), 126 m dat ? (Gaisler 1956)

Distribution

First Staněk (1932) and Štěpánek (1938) reported this species in Domica cave in Slovenský kras Mts. The other detailed records are from 50s and 60s (Vachold 1956, 1960, Grulich & Povolný 1955, 1956, Gaisler & Hanák 1972)

The present record evidences a presence of *R. euryale* in 30 localities situated in 7 geomorphological units (13 mapping squares, 3 1% of territory of Slovakia) (Fig 3). The localities are situated in two separate regions. The first is Slovenský kras Mts and adjacent mountains (piedmont of Volovské vrchy Mts). Here, most of localities are situated (70%), and an occurrence of the mediterranean horseshoe in this region has been many times mentioned (e.g. Horáček et al 1979, 1995, Horáček & Červený 1984, Uhrin 1992, 1993b). This region is considered to be a centre of its distribution in Slovakia. The second region is Revúcka vrchovina Mts, mainly its

karst part, Drienčanský kras, and also several localities in the Rimavská kotlina basin. Findings in this region are also connected with occurrence of karst landscape (Gulička 1975, Horáček & Červený 1984, Horáček et al. 1979, original data). Also the present data prove that stable population lives also in this part of Slovakia (Horáček & Červený 1984).

Besides these regions, this species was recorded also in Muránska planina Mts. in Kostolík cave in 50s (Vachold 1955, Hanák & Anděra 1980, Horáček et al. 1979). Occasional controls in that locality as well as in other caves neighbouring it did not prove an occurrence of this species since 1970, and the region seems abandoned by this species (Horáček & Červený 1984), which was confirmed also by the recent investigations (Uhrin 1995).

Hitherto the most northern record of this species comes from Pružinská cave in Strážovské vrchy Mts. (Zajonc 1963) in 570 m a. s. l. Since that time, the occurrence of the species in that region has not been confirmed and according our present knowledge it seems to be unlikely. Similarly less likely is the occurrence in western Slovakia reported by old literature (Vachold 1960, Gaisler 1956).

Altitudinal range of records is 220–943 m a. s. l. Most of them (70%) lie in 220–400 m range (winter roosts 75%, summer roosts 83.4%). Also the localities of osteological findings are in this range, viz., thanatocenoses in Domica cave and food of *S. aluco* in Zbojnica cave and Jasov-Teplica. An exception to this rule is only finding of one holocene skull in Pustá cave in Nízke Tatry Mts. in 943 m (Rybář 1980). This record bring a different light also on the records from Demänovská cave, which were evaluated as invalid (Gaisler 1956).

Ecological notes and changes in numbers

All hibernacula are natural caves. A high turnover in numbers and a high activity during winter period seems to be very characteristic in this species. In Domica cave, on February 26, 1992, in a cluster of 70 active and mating individuals was observed (Uhrin 1993b). A number of bats found in a hibernaculum varied from 1 individual to colonies with a maximum number of 1632 individuals (average 181.7 per one check, $n=41$ checks). It is worth of mentioning that at only 16 (39%) of all winter records the number of bats per site was lower than 10 individuals. Already this datum suggests an extreme sociality of that species which considerably affects also a pattern of its local distribution.

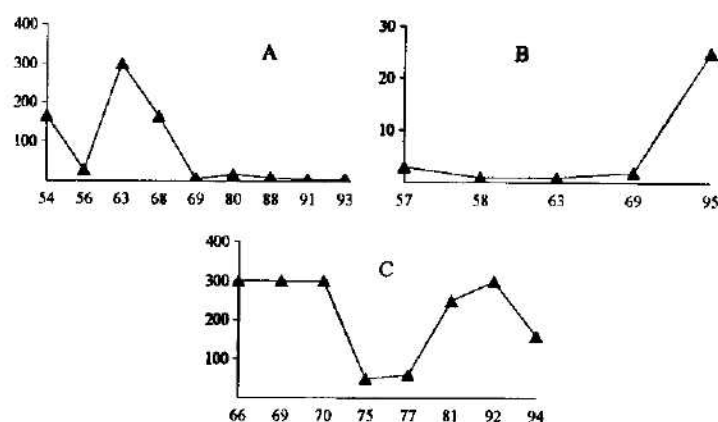


Fig. 7. Changes in abundance of *Rhinolophus euryale* in some localities: A – Ardoovská cave (winter censuses), B – Jasovská cave (winter censuses), C – Liščí diera cave (summer censuses).

Evaluation of long-term changes is difficult. The abundance of a summer colony in Liščia diera cave seems to be stable with short dropping in 1975 and 1977, in Ardovská cave records show a decrease in abundance during the winter periods. On the other hand, abundance in Domica cave was stable last several years (appr. 1000 ind.) (see survey of records).

Except for 5 synanthropic roosts (20% of all localities), the summer roosts are natural caves, as a rule. The synanthropic roosts include spacious lofts of churches and a monastery, lofts of smaller buildings (Jasov, Krásnohorská Dlhá Luka, Silická Jablonica in Slovenský kras Mts and Malé Teriachovce in Rimavská kotlina basin), and a cellar-like room in a castle (Krásna Hôrka in the piedmont of Volovské vrchy Mts). These synanthropic tendencies are generally exceptional and may be connected with the extreme conditions at the margin of the species distribution range (Horáček & Zima 1979). The number of bats observed in these synanthropic roosts varied from 2 to 100.

A total of 305 individuals of this species were netted. From 299 individuals with sex determined males presented 75.3% (71ma, 20ms, 58mj, 76m), and females 24.7% (49fa, 8fs, 12fj, 5f).

CONCLUSIONS

Summarizing all the data available on local distribution and abundance trends in three horseshoe species, including the numerous data from the period of last 15 years, which mostly were not published as yet, the present paper provides a serious basis for a detailed reevaluation of previous ideas concerning distributional and abundance statuses of all these species in Slovakia. It is to be pointed out that the territory of Slovakia is in that respect a very critical – the two horseshoe species, *R. ferrumequinum* and *R. euryale*, reach just here the northern margins of their distribution ranges, at least in the Central Europe, the remaining one, *R. hipposideros*, is the form which drastic decline in most of the western Europe calls for a very careful investigation for which a detailed comparative data on the long-term abundance trends from any area are of a utmost importance.

As concerns *R. hipposideros*, our data suggest that in comparison with the western Europe where population decline in seventies resulted even in a large scale local extinctions and, in general, has reduced the population abundances to about 10% of original state (e.g. Roer 1981, Schober & Wilhelm 1984), in Slovakia, the population decrease even in that period was minute only. Recent period is, correspondingly with the other regions of Central Europe, characterized with stabilization of numbers or even with a slight increase. This corresponds both to data from Hungary (cf. Dobrosi 1995) and from Moravia (Gaisler 1991) which differ from those in Bohemia and/or Poland where the abundance trends have shown the pattern corresponding to the western Europe. In comparison with sixties, a shift in roosting strategy of breeding colonies of the Slovak population is apparent. During the recent period no one cave-dwelling colony was found. Summarizing all these data, one can hypothesize that the territory of Slovakia may have belonged to the centre of distribution range of this species where a population status is not influenced by fluctuations at the range margins in a broadest sense.

Worth mentioning is that neither in the other two species, which marginal records come just from the Slovak territory, our data have shown any extensive abundance decline and/or range restrictions comparable to the trend in the west European populations. Nevertheless, a shift in roosting strategy is apparent (cf. also Horáček 1984). The recent records of both the species, and results (though negative) of searching for them in possible marginal areas of their distribution in Slovakia, enable us to reevaluate in new a course of their distribution margins.

In a case of *R. ferrumequinum*, it should be stressed that almost for sure the species do not colonize any of the western ridges of the Slovak Carpathians and this also concerns of the most of the regions north of Slovenské Rudohorie Mts, i.e. the whole the northern part Slovakia. The margins of actual distribution range in central Europe can thus be delimited with a border surroundings of Slovenský kras Mts, southern regions of the central Slovenské Rudohorie Mts (i.e. incl. Muránska planina Mts) and than the Pilis Mts and Buda Hills in Hungary. Most of the Carpathian basin and the Vienna basin are not colonized by this species. Worth mentioning are, of course, sporadic but not exceptional winter records in Moravian karst, and some other localities (Javoříčské caves, Lednice, Pernštejn). They as well as a record in southern Poland suggest either a capability of seasonal movements of about a hundred kms and/or, in case of Moravian records a possible effect of a marginal population in the region of the Vienna basin. Otherwise, there is an apparent gap in distribution from the Pilis Mts to the southwestern Germany.

In a case of *R. euryale*, the situation is quite a different. Except for temporal offshoots up to 50 km from contemporary sites (e.g. Muránska planina Mts), the distribution area is a very strictly delimited and populated in quite a stable way. It includes a karst region in Rimavská kotlina basin and, as a centre, the Slovenský kras Mts. and its Hungarian part, the Aggtelek karst. Even the extensive bat investigations undertaken in Hungary, Austria and other neighbouring countries during the recent years (cf. e.g. Dobrosi 1995) did not prove this species anywhere except for the abovementioned regions. The population under study is thus to be looked upon as a remarkable example of a quite isolated subpopulation, which distribution is strictly delimited and far distant of the range of continuous species distribution. It is undoubtedly a very northern-most margin of the species range and at least because of that reason, the Slovak population of *R. euryale* is worth of a profound continuous monitoring and a detailed study which should also establish the most effective protective measures.

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BOOK REVIEW

BERGQUIST N R (ed.) **Immunodiagnostic Approaches in Schistosomiasis** Chichester-New York-Brisbane-Toronto
John Wiley & Sons, 1992, XV+135 pp. Format 160×230 mm, hardcover, price Lstg 19 95, ISBN 0-471-93401-1

This volume represents a special edition of Proceedings of Symposium held in Shanghai in 1990 under participation of United Nations Development Programme (UNDP), International Centre for Genetic Engineering and Biotechnology (ICGEB), World Bank and WHO Special Programme for Research and Training in Tropical Diseases (TDR). It was compiled by 51 international experts from Europe, USA and Canada, Africa, Latin America and Asia. The brief introduction emphasizes the usefulness of immunodiagnosis in schistosomiasis. It has become evident, that parasitological techniques frequently, even after repeated examinations, fail to reveal low-intensity infections. For this reason, epidemiological survey teams have incorporated serology as a way of improving the diagnostic record in geographic areas characterized by a low level of transmission. The volume consists of 13 chapters, each focusing on different aspects of immunodiagnosis. Each chapter actually presents a scientific report illustrated by figures, photomicrographs, diagrams and tabular reviews, and concluded with a list of selected references.

First three chapters provide insights into the immunodiagnosis and serological techniques of schistosomiasis. Chapter 4 contains information on collaborative study on antigens and methods for immunodiagnosis of schistosomiasis in China. Investigators in Brazil (chapter 5) demonstrated their epidemiological studies of schistosomiasis mansoni performed in the Sao Paulo State over a period of 20 years. 2.5 to 4.0 times higher prevalence rates were found by immunological, in comparison with parasitological techniques. A team of Kenyan and British authors (chapter 6) presented an interlaboratory trial of serologic tests for schistosomiasis in Kenya using crude and purified *Schistosoma mansoni* egg antigen. Chapter 7 is devoted to experiments performed in Heidelberg and Mali for evaluation of immunogenic activity of recombinant *S. m.* antigens. In chapter 8 alternative preparation of *S. m.* egg antigens for circumoval and intraoval precipitin tests for use in endemic area is described.

Chapters 9 and 10 are concerned with immunodiagnosis based on enzyme markers and with antigen detection in urine samples. Chapter 11 reviews detection of the circulating anodic antigen which offers a number of advantages over the detection of antibodies and allows the follow up of antigenaemia, the correlation between antigen concentration in serum or urine and the worm burden, and of the drug treatment. With recent advances (chapter 12) in recombinant DNA methods, it is now possible to identify schistosome genes that encode antigens, identify the gene products, produce large quantities of the antigen in bacteria, purify the antigen and evaluate its diagnostic potential. The final chapter focuses on conclusions and general recommendations for development of immunodiagnosis according to a strategic plan specifying operational parameters in advance according to criteria established in concert with basic research and health service laboratories, field epidemiologists, community health workers and industry.

Schistosomiasis, a chronic debilitating disease currently afflicts 200 to 300 million people throughout the world, causing 800,000 deaths each year. It is still increasing in incidence today. The importance of this parasitosis can be documented by the participation of the world organizations mentioned above in this publication.

Jindřich Jira

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- (b) Lonberg E. & Gustavson C. 1937: Contribution to the life history of the striped wrasse. *Ark. Zool.* 29(7): 1–16.
- (c) Lattin G. de 1967. *Grundriss der Zoogeographie*. Jena: Fischer Verlag, 602 pp.
- (d) Makin D. 1989: The status of bats in Israel. Pp. 403–408. In: Hanák V., Horáček I. & Gaisler J. (eds.) *European Bat Research 1987*. Praha: Charles Univ. Press, 718 pp.
- (e) Schornikov E. I. 1969: A new family of Ostracoda from the supralittoral zone of Kuril Islands. *Zool. Zh.* 48: 494–498 (in Russian, Engl. abstr.).
- (f) Nikolajev G. V. 1987. *Plastinchatousye zhuki (Coleoptera, Scarabaeoidea) Kazakhstana i Sredney Azii* [Scarabaeoidea (Coleoptera) of Kazakhstan and Central Asia]. Alma-Ata: Izd. Nauka KazSSR, 232 pp. (in Russian).
- Nikolaev G. V. 1987: *Plastinčatousye žuki (Coleoptera, Scarabaeoidea) Kazakhstana i Srednej Azii* [Scarabaeoidea (Coleoptera) of Kazakhstan and Central Asia]. Alma-Ata: Izd. Nauka KazSSR, 232 pp. (in Russian).
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